Working Draft

Monitoring Streambanks and Riparian Vegetation

Multiple Indicator Monitoring
Ervin Cowley and Tim Burton
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Introduction

The purpose of the protocol is to provide an efficient suite of monitoring procedures that, along with current livestock grazing management practices (timing, frequency, intensity and duration), can be used to determine if the riparian vegetation and streambanks are responding as anticipated in a timely manner. Appropriate vegetative cover and streambank stability is essential for water quality and aquatic habitat. Monitoring effects of current year grazing practices provides information necessary to make adjustments to grazing practices necessary to maintain or improve riparian and streambank conditions. However, short-term monitoring alone does not provide the data necessary to determine condition and trend. The protocol also provides monitoring procedures that measure changes to riparian vegetation and streambanks.

Adaptive management requires knowledge of the current conditions, potential or capability of riparian sites, current management, effects of the management on the resources, and possible management changes that may be made to move the current condition toward the desired condition. Single indicators of condition or trend are usually not adequate to make good decisions. Information on the condition and trend of the vegetation and streambank plus the current management help establish "cause-and-affect" relationships that are important to make appropriate decisions.

This monitoring protocol provides methods for six indicators for stream associated riparian areas. Three of the indicators: modified greenline, modified woody species regeneration, and streambank stability, provide data and information concerning the present condition and trend of riparian vegetation and streambanks are called effectiveness monitoring. Monitoring procedures for vegetation include modifications of methods described by Winward (2000) and Coles-Ritchie *et al* (2003). Streambank stability is a modification of the method described by Henderson *et al* (2003).

Monitoring implementation the management practices includes modified Extensive Browse Utilization (Interagency Technical References, 1996), modified stubble height described in Interagency Technical Reference (1996) and Challis Resource Area (1999), and streambank alteration described by Cowley (2004). This is called implementation monitoring. These procedures provide information that helps make short, year-to-year, adjustments to livestock grazing management practices necessary to meet management objectives

Preliminary field studies indicate that procedures described in this protocol provide information useful for making decisions in the adaptive management process. Table 1 provides a summary of information derived from using the protocols described in this document for two sites: a highly disturbed site and moderately grazed site. Comparisons were made between continuous measurements and plots. Greenline vegetation in the moderately grazed site had 79 percent agreement with the moderately grazed site (see Appendix A), while greenline vegetation on the highly disturbed site was 99 percent. One site had complex vegetation and streambank conditions. While the second site was relatively uniform. Using a defined area of the plot tends

to focus the determination of the vegetation community type more closely. Some small isolated community types were missed using the plot.

Table 1—Comparison of data obtained from a highly disturbed site and a moderately grazed site.

Highly disturbed Site		Moderately Grazed Site	
% hydric vegetation=	10%	% hydric vegetation=	68%
% Stable banks=	2%	% Stable banks=	62%
% Covered banks=	90%	% Covered banks=	90%
Stubble Height=	1.6	Stubble Height=	4
Percent altered=	82.83	Percent altered=	22.89
Woody Use=	70-100%	Woody Use=	0-30%

Selecting Designated Monitoring Areas

Designated monitoring area (DMA) is the location in riparian areas and along the streambanks where monitoring takes place. DMAs are not key areas, rather they are that are monitored to provide information concerning the management of critical areas such as riparian areas. Instead they should be representative of grazing use specific to the riparian area being assessed and should reflect what is happening in overall riparian areas as a result of on-the-ground management actions. It should not reflect an average amount of use in all riparian areas of the stream reaches in the pasture but rather reflect livestock use only in those stream reaches where livestock are actually using riparian areas (see Appendices I and J).

The following criteria are used to select DMAs.

- DMAs represent riparian areas used by livestock. Select the site based on the premise that if proper management occurs on the area, the remainder of the riparian areas within a pasture or use area will also be managed within requirements.

- Select sites that are representative of use, not an average for the stream within the pasture or allotment. For example, if one-half mile of a stream reach in the pasture is used by livestock and one mile is not used because it is protected by vegetation, rock, debris, or topography, the DMA location should represent the stream reach that livestock use.

- Monitoring sites should have the potential to respond to and measure changes in grazing management. Livestock trails associated with livestock use of the riparian may be included in the DMA.

- Avoid selecting sites on which vegetation is not a controlling factor such as cobble, boulder, and bedrock armored channels.

- Do not place DMA in streams over four percent gradient unless they have or should have distinct developed flood plains.

- Avoid water gaps and small trail areas, e.g., along fences, that do on represent livestock grazing use along the riparian area. These areas may be monitored to determine changes

over time, but should not be considered as representing the riparian area. This monitoring usually documents changes that occur when physical improvements such as hardening water gaps and trails with gravel to reduce adverse impacts at the site.

Training

Training is essential for personnel conducting monitoring. Studies have found crews who were trained substantially increased the precision and repeatability of the procedures.

Transects

Transects should be permanently marked. Reference markers, e.g., steel posts, should be at least 30 meters (100 feet) away from the plot location. Since these transects are along the greenline and the greenline moves with the stream, markers should be placed a sufficient distance from eroding banks to reduce the risk of losing the marker. Transects should be at least 100 meters (328 feet) long. Permanently mark starting and ending points on each side of the stream.

Monitoring Procedures

Monitoring usually begins at the lower end of the transect on the right hand side (looking up stream).

1. Beginning at the transect marker, take two paces (four steps) along the greenline and place the monitoring frame down at the toe of the boot with the center bar along the greenline (see Appendix B). This will place one modified Daubenmire monitoring frame on each side of the greenline.

2. Using the appropriate technique(s) described in this protocol, measure and record the appropriate data. Continue along the greenline placing the monitoring frame frame down each monitoring frame (two steps). When the upper transect marker is reached, cross the stream and continue the procedure down the other side to the end marker.

3. The procedure should not be used if a high flow (flood) event occurs prior to doing the monitoring. In that situation, water's energy and sediment will make it difficult, if not impossible, to determine if the effects are a result of the current grazing season or past grazing season.

Effectiveness Monitoring

Effectiveness monitoring is designed to answer the question, Are the management practices currently applied to the area, achieving the desired results? These procedures are designed to measure changes in vegetation and streambank stability over time, i.e., trend. Effectiveness monitoring is usually conducted every three to five years on riparian areas and streambanks. This period of time is usually necessary to detect changes.

Greenline (Modified)

Objective: Estimate the vegetation composition along the greenline by riparian community type or dominate vegetation.

The greenline is the first relatively continuous lineal grouping of rooted perennial vegetation that is at least 12 inches wide and has at least 50 percent vegetative cover. Greenlines are usually slightly below the bankfull flow. They are approximately parallel to the stream flow, not perpendicular. (see Appendix B, Figure 6) The greenline is defined along the base of the plants and not at the edge of the vegetation canopy (see Appendix B, Figure 1). Appendix B provides examples of greenline location.

General Instructions

- The greenline may be submerged during high (above bankfull) flow and may be some distance away from water during low flow.

- Bare ground or sparsely vegetation areas under a shrub canopy is not considered the greenline. The base of the shrub is the green line. (see Appendix A, Figure 1)

- When banks are eroding or when a stream becomes entrenched, the greenline may be located high above the stream and consist of upland plants. Record the upland species as the greenline because they are the first perennial vegetation. (see appendix A, Figures 2, 9, and 11)

- The main channel banks and not islands are monitored. Consider islands at bankfull flow even though at low flow channels may be dry at base or low flow. (see Appendix B, Figure 3)

- Greenline does not occur on unstable slump features. (see Appendix B, Figures 2, 6, and 7)

Specific Instructions

1. Evaluate the vegetation within the monitoring frame on the floodplain side of the greenline.

2. At each plot, identify and record the overstory, dominant, co-dominant, and/or sub-dominant vegetation. Overstory and dominant and co-dominant plant species are separated by a forward slash. The sub-dominant is indicated by parenthesis. An example of an overstory with co-dominant vegetation in the understory is Sabo/Juba/Popr (*Salix boothii/Juncus balticus/Poa pratensis)*. An overstory with a dominant and sub-dominant understory example would be Sabo/Popr(Caut) (*Salix boothii/Poa pratensis(Carex utriculata*).

3. Record data on the Greenline form (see Appendix H - 5) by dominant vegetation (community type) to the nearest 0.5 monitoring frame on the field form or in a computer.

At least 25 percent of the monitoring frame must be one vegetative type to be recorded as 0.5 monitoring frame. When two vegetation types are in the plot and one type is less than 25 percent, record only the majority type.

4. Record shrub or tree overstory when the monitoring frame is within the drip line of the shrub or tree (see Appendix B, Figure 4)

A continuous measurement along the greenline as described by Winward (2000) may also be used.

Woody Species Regeneration (Modified)

Objective: Estimate the species, number, and age-class of woody species plants within one meter either side of the greenline.

1. The woody species regeneration plot is 1 meter by 0.4 meters on each side of the greenline.

2. Place the monitoring frame perpendicular to the greenline and count the number of woody plants by species rooted within the monitoring frame and record on the form shown in Appendix H. (Do not count woody species canopy cover as woody species within the plot.)

3. Move the monitoring frame away from the greenline and place it at the end of the first monitoring frame and repeat the procedure (see Figure 1).

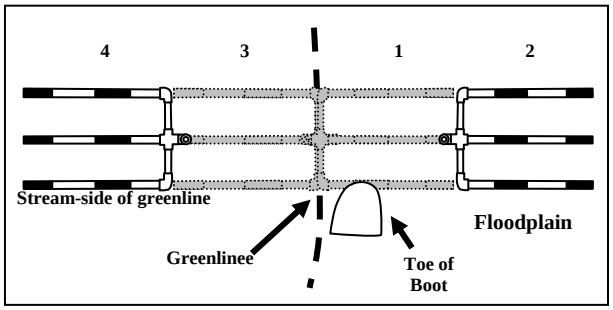

Figure 1—Woody species regeneration plot is 0.4 meters by 1.0 meter. The plot is defined by placing the monitoring frame perpendicular to the greenline. The frame is placed end-to-end on each side of the greenline. The numbers indicate the sequence of frame placement to determine the amount of woody species regeneration.

Streambank Stability

General Description

Streambank stability is measured using a pace-plot transect and is expressed as a percentage of the streambank in one of six stability classes (see below). It is intended for long-term trend monitoring and should read on 3 to 10 year intervals.

Streambank Stability Classification

Use Appendices B, C, D, and E. Record the data on the appropriate "Streambank Stability" form in Appendix H by one of the following six bank stability classes:

CS - Covered and stable (non-erosional). Streambanks are covered with perennial, and/or cobble (6 inches or bigger), boulders, bedrock or anchored wood (4 inches in

diameter or larger) to protect them from the erosive effects of water. Streambanks do not have indications of erosion, breakdown, shearing, or trampling that exposes plant roots. Banks associated with gravel bars having perennial deep-rooted vegetation along the edge of the floodplain line are in this category.

CU - Covered and unstable (vulnerable). These streambanks are covered with perennial vegetation and occur where undercutting by water may cause breakdown, slumping, nicks, bank shearing, and/or fracturing along the bank.

US - Uncovered and stable (vulnerable). Streambanks having consolidated soils high in clay, particularly in the lower part of the streambank, may be uncovered and stable. These banks are vulnerable to high flows, particularly winter flows with floating ice. Uncovered, stable banks may also be compacted streambanks trampled by concentrations of ungulates, people trails, vehicle crossings, or other activities that cause compaction. Such disturbance flattens the bank so that slumping and breakdown does not occur even though vegetative cover is significantly reduced or eliminated.

UU - Uncovered and unstable (erosional & depositional). These are bare, eroding streambanks and include all banks mostly uncovered that are at a steep angle to the water surface. When the bank is not present due to excessive bar deposition or to stream side trampling, the bank will be classified "uncovered/unstable."

FB - False Bank (vulnerable). Stream banks have slumped in the past but have been stabilized by relatively shallow-rooted vegetation. These banks are usually lower than existing banks are covered/unstable. False banks vegetated with deep-rooted riparian vegetation may be considered stable and should be counted separately and added to the stable category.

UN - Unclassified. Side-channels, tributaries, springs, road crossings, etc. cause a break in a streambank. Livestock or wildlife trails are not included in this category.

Streambank Cover

Streambanks are considered covered if they show any of the following features:

1) Perennial herbaceous and/or woody vegetation provides more than 50 percent ground cover the vertical height of the streambank (Bauer and Burton, 1993).
2) Roots of vegetation cover more than 50 percent of the bank (deep rooted plants such as willows and sedges provide such cover).
3) Cobble size rocks (at least 6 inches in diameter), boulders, or bedrock cover more than 50 percent of the streambank surfaces.
4) Logs, at least four inches in diameter, cover more than 50 percent of the bank surfaces. At least 50 percent of the bank surfaces are protected by a combination of the above.

Streambank Stability

Streambanks are considered stable if they do not show indications of any of the following features:

1) Breakdown - Obvious blocks of streambanks broken away and lying adjacent to the bank breakage.
2) Slumping or False Bank - Bank has obviously slipped down, cracks may or may not be obvious, but the slump feature is obvious.
3) Bank Shearing - occurs when animals walk along the streambank or cross the stream and shear or break off portions of the streambank. It is recognized by a shear plane with obvious hoof marks on the streambank. Included the total length of bank disturbance associated with the shearing.
4) Fracture - A crack is visibly obvious on the bank indicating that the block of bank is about to slump or move into the stream.
5) Vertical and Eroding - The bank is mostly uncovered as defined below and the bank angle is steeper than 80 degrees from the horizontal.

Streambank Stability Measurements

At each plot location, evaluate the condition of the streambank within the plot and record the stability class. If the plot along the greenline does not include the streambank, project the plot (50 cm) to the streambank and record the stability class. (see Appendix E, Figures 1 and 2)

Implementation Monitoring

Implementation monitoring measures attributes to help determine if livestock management is being applied as prescribed. It provides information to assist with making decisions under adaptive management. The three monitoring methods include stubble height, woody species incident of use, and streambank alteration.

Stubble Height

Objective: To determine the residual vegetation (key species) height remaining during the grazing season or after grazing is completed for the year.

Sampling is done using a “step-point” transect in the riparian area. For herbaceous key species, the sample area will be a 3-inch diameter circle directly in front of the sampler's toe. Because riparian key species may grow tightly together with no distinct separation of one plant from another, sampling usually does not try to separate out distinct plants. Using a ruler which shows quarters or tenths of an inch, measure several places within the circle to determine an "average" leaf stubble height (within one inch). Measure plants from the ground surface to the top of the remaining leaves. Account for very short leaves as well as the tall leaves. Do not measure seed stalks. The determination of an "average" stubble height will take some practice. Be sure to include all of the key species' leaves within your sample. The easiest method of doing this is to grasp the sample in the sampler's hand, stand the leaves upright and then measure the average height.

Measure a minimum of 30 samples per transect or sample more points on the transect if stubble height variability is high (100 is recommended). Once the samples are collected, the **median not the mean (average) height** is calculated for the riparian key species in the key area. Median riparian stubble height is calculated by listing, in ascending order of heights, from the measurement with the tallest height to the measurement of the shortest height. The median is the single mid-point for an odd number of samples and the average of the two "co" mid-points for an even number of samples.

Woody Species Utilization (Modified Extensive Browse Method)

General Description

The Extensive Browse Method provide a rapid method for determining woody species utilization, form classes, and hedging form class. Data is collected along the transect described above. Key species must be selected prior to gathering the data.

1. At each plot location along the transect, select the woody specie(s) nearest to the toe of the boot. The selection zone is a 180-degree arc in front of the observer within about one meter of the toe of the boot (see Figure 2).

2. The plant selected should be less than four feet tall. Plants over this height are out of reach for most animals. Randomly select a branch and determine the number of current year's growth shoots that has been used by large herbivores.

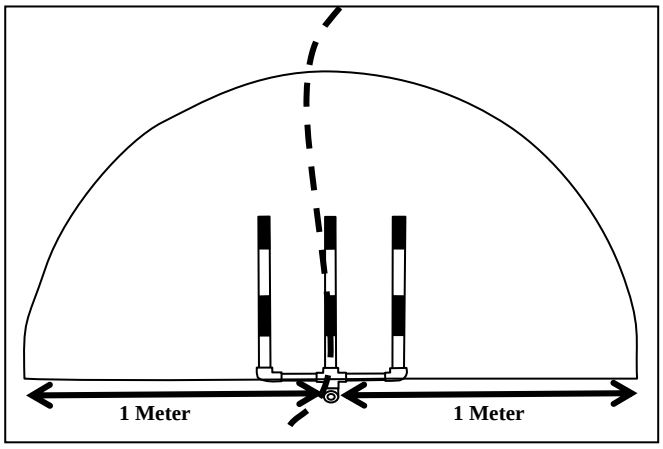

Figure 2—Select the nearest shrub, rooted or canopy cover, within 1 meter from the center of the monitoring frame near the toe of the boot. Select only shrubs less than four feet tall.

   a. Select a branch at random. One method of determining a random location is to use a clock with the direction of travel along the transect being the 6 o'clock to 12 o'clock line. Select a random number from 1 to 12 to determine the location for the sample. For example, if the selected number is 9, the 9 o'clock position is the location of the selecting the branch or branches necessary to look at 10 twigs. A random number table or generator may be used to determine the number. Another simple method is to use a second hand on an analog clock or the seconds on a digital clock. For example, 20 seconds represents 4 o'clock. Using a digital clock, round seconds to the nearest five second interval shown below.

0 = 12 o'clock	10 = 2	20 = 4	30 = 6	40 = 8	50 = 10
5 = 1	15 = 3	25 = 5	35 = 7	45 = 9	55 = 11

b. Evaluate ten leaders of annual growth for evidence of browsing. Indicators of browsing are the removal of the terminal growing bud and part or all of the current year's growth. Record the appropriate number on the form. (see Appendix H)

c. Observe and record the form class as described below (see Appendix F).

Class No.	Form Class
1	All available, little or no hedging
2	All available, moderately hedged
3	All available, severely hedged
4	Partially available, little or no hedging
5	Partially available, moderate hedging
6	Partially available, severely hedged
7	Unavailable
8	Dead

d. Availability refers to the current year's growth available for livestock use.

e. When more than one form class exists on a single plant, determine the predominant or average condition and record the appropriate form class.

f. Hedging is determined by the length and appearance of the two-year old wood immediately below the current year's leader growth. Hedging is described in three degrees of use, little or no hedging (Figure 2), moderately hedged (Figure 3, and severely hedged (Figure 4).

g. The length of the two-year-old wood reflects the relative vigor of the plant. Since hedging evaluated the two-year-old wood, it reflects the previous years use. The current years use is reflected in the utilization section.

h. The three degrees of use help evaluate the relative condition of browse plants and short-term effects of intensities of leader use.

Figure 3—Little or no hedging – Two-year-old wood is relatively long and only slightly unaltered. Most riparian species grow with a strong central stem with annual growth from a terminal bud. The central stem is relatively unaltered.

Figure 4—Moderately Hedged- Two-year-old wood is fairly long but most of it has been altered from the normal growth form. The central stem has multiple branching from the one point.

Figure 5—Severely hedged – Two-year-old wood is relatively short and/or strongly altered. Strong branching from a single point on the central stem is evident.

Streambank Alteration

General Description

The protocol describes a method that may be used to determine the percent of the linear length of streambank alteration that can be directly attributed to large herbivores, e.g., cattle, horses, sheep, bison, elk, and moose, during the current grazing season. As previously cited, bank alteration increases the risk of erosion caused by water, ice, and/or debris.

The part of the streambank that will be measured using this protocol is an area 20 cm on each side of the greenline. It focuses on that portion of the streambank that which is most subject to the erosive effects of water.

Streambank Alteration Definition

Streambank alteration occurs when large herbivores, e.g., elk, moose, deer, cattle, sheep, goats, and horses, walk along streambanks or across streams. The animal's weight can cause shearing of the streambank that causes direct breaking down of the streambank and widening of the stream channel. It also exposes bare soil which increases the risk of erosion to the streambank. Animals walking along the streambank may increase the amount of soil exposed to the erosive affects of water by breaking or cutting through the vegetation and exposing roots and/or soil. Excessive trampling causes soil compaction resulting in decreased vegetative cover, less vigorous root sytems, and more exposure of the soil surface to erosion.

Hoof shearing is usually the most obvious streambank alteration. It is recognized by the shear plane with obvious hoof marks on the streambank. Include the total length of

streambank disturbance directly associated with an occurrence of shearing, not just the width of the hoof mark.

Trampling is considered streambank alteration: 1) when streambanks are covered with vegetation and have hoof prints that expose at least 12 mm (about ½ inch) of bare soil and/or roots; 2) when streambanks with a broken vegetation cover or are not vegetated and have a hoof print at least 12 mm (½ inch) deep (Measure the total depression from the top of the displaced soil to the bottom of the hoof impression.); and 3) when streambanks with compacted soil are caused by large herbivores repeatedly walking over the same area is considered streambank alteration even though the animal's hoofs sink into and/or displace the soil less than 12 mm (½ inch).

Large herbivores trampling and trailing on top of terraces, above the active floodplain is not considered streambank alteration. Hoof marks indicating shearing on the streambank and or terrace wall and trampling at the base of the streambank or terrace wall is considered streambank alteration (see Appendix D, Figure 4).

Broken Vegetation Cover

Broken vegetation cover is small areas of vegetation mostly surrounded by bare ground. Patches are usually 12 inches or less in diameter in diameter. Generally the patches are caused by large herbivores trampling the area (see Appendix F, Figures 3 an d 4).

Streambank Alteration Monitoring Frame

The streambank alteration plot frame may be constructed from a number of materials. One-half inch Schedule 40 PVC pipe is a suitable inexpensive material. The plot is 20 cm X 50 cm on each side of the greenline. The plot contains five lines across the plot that is used to determine the amount of linear length that has streambank alteration. Appendix C shows some possible suitable configurations. A frequency monitoring frame, at least 40 cm X 40 cm, may be used by marking the frame appropriately.

Equipment

Streambank Alteration Form
Streambank Alteration monitoring frame
Existing photographs
Camera and film
Picture identifier (colored paper such as yellow or gray works well)

Procedure

The procedure should be used as one attribute that indicates that livestock management should be evaluated. It should not be used as the sole indicator of the need to move livestock. The recent studies found that the methods do not have adequate precision to set thresholds. In addition, there is little or not scientific data that provides a basis for establishing thresholds (Henderson, 2004). This procedure is most appropriately used in

conjunction with other indicators, e.g., stubble height, woody species utilization, greenline vegetation, and woody species regeneration), to review livestock management practices and make changes for future use.

The procedure should not be used if a high flow (flood) event occurs prior to monitoring. In that situation, water's energy and sediment will make it difficult, if not impossible, to determine if the effects are a result of the current grazing season or past grazing season.

1. Begin on one streambank and proceed along the streambank for at least 363 feet, about 110 meters (see Apendix C, Figure 1). Begin monitoring the transect by taking one pace from the monitoring location stake. Place the streambank alteration plot frame along the greenline and against the toe of the boot. (see Appendix B, Figure 2).

2. Looking down, determine the number of lines within the plot that intersect streambank alteration (see Appendix F). Record the number of lines that intersect streambank alteration in the appropriate column on the Streambank Alteration Form. Record only one occurrence of alteration, trampling or shearing, per line. This process is repeated every pace (two steps) for approximately 70 to 75 sampling points (depending upon the length of the step) on each side of the stream. **It is important that the observer determine only the current year's streambank damage and distinguish between livestock-caused and other alterations when possible.**

3. **Rules for consistency:**

    a. Place the center of the frame over the greenline and record the alteration information. This helps to maintain consistency in observing the portion of the bank most susceptible to an increased risk of damage.

    b. When there is a vertical or near-vertical terrace wall, pace along greenline on top of the terrace, placing the center of the frame along the greenline at the end of the toe. Record only direct alteration occurring on the terrace wall or the streambank.

    c. On streambanks with fully developed, deep-rooted hydric vegetation, *e.g.*, *Carex* spp., *Juncus* spp., and *Salix* spp., hoof prints or trampling is not recorded as alteration unless the plant roots are exposed. Hoof shearing along the streambank is alteration.

    d. Compacted livestock trails, *i.e.*, trails that have been created over some time by livestock walking along the same line, compacting the soil and excluding vegetation, that are on or cross the greenline and which were obviously used during the grazing season, are counted as trampling.

    e. Roads and tributary streams are not counted. Continue to pace directly across the area until the greenline in reached. Record separately on the form any samples that are on the road or water.

    f. When obstructions such as trees, shrubs, or other physical impediments are encountered, sidestep at 90-degrees from the transect line and continue pacing

parallel to the transect to avoid the obstruction. Project the lines from the end frame to the streambank and record the hits. Return to the original transect as soon as possible by sidestepping back to the transect line and continuing.

g. When the greenline is away from the stream channel or the edge of the terrace wall, the pacing should continue along the edge of the streambank or terrace wall (Appendix D, Figure 7)

Calculation

The percent streambank alteration is calculated by dividing the number of trampling and shearing instances on both sides of the stream by the total number of sample points (5 times the number of sample sites) on both sides of the stream and multiplying by 100.

Example

Number of of samples disturbed recorded (both sides of the stream)	= 357
Total number of samples points (5 sampling points per pace)	150 * 5 = 750
Total percent of the streambank disturbed	357 / 750 * 100 = 47.6%

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Winward, A.H. 2000. Trend monitoring of riparian vegetation. California Rangeland Interagency Video Series. 24 minutes 06 seconds.

Appendix A

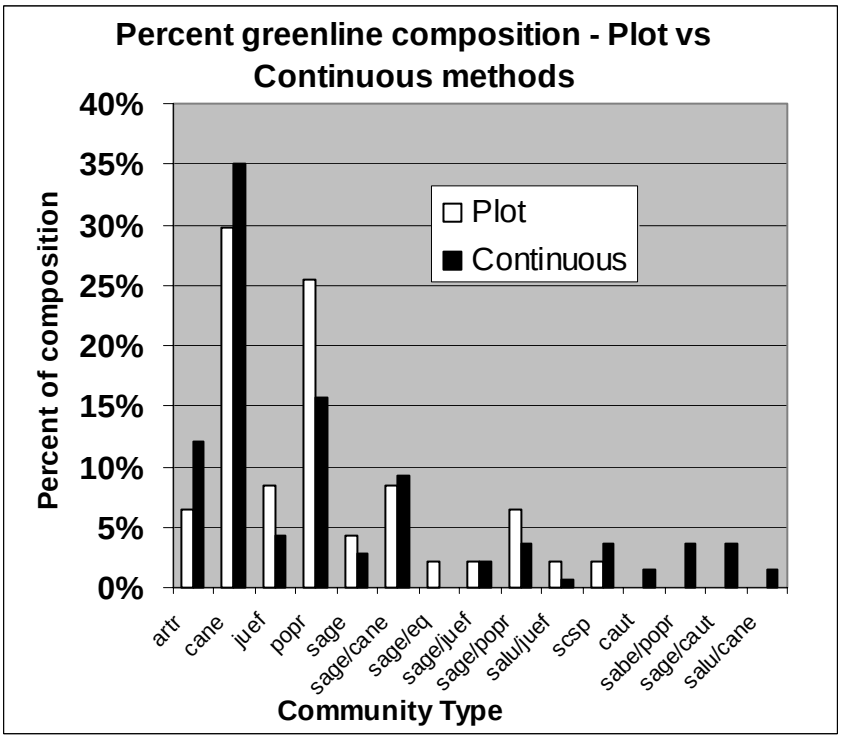


Figure 1. A comparison of estimates of dominant riparian vegetation community type composition along the greenline, using the plot method and the continuous measurement approach suggested by Winward (2000).

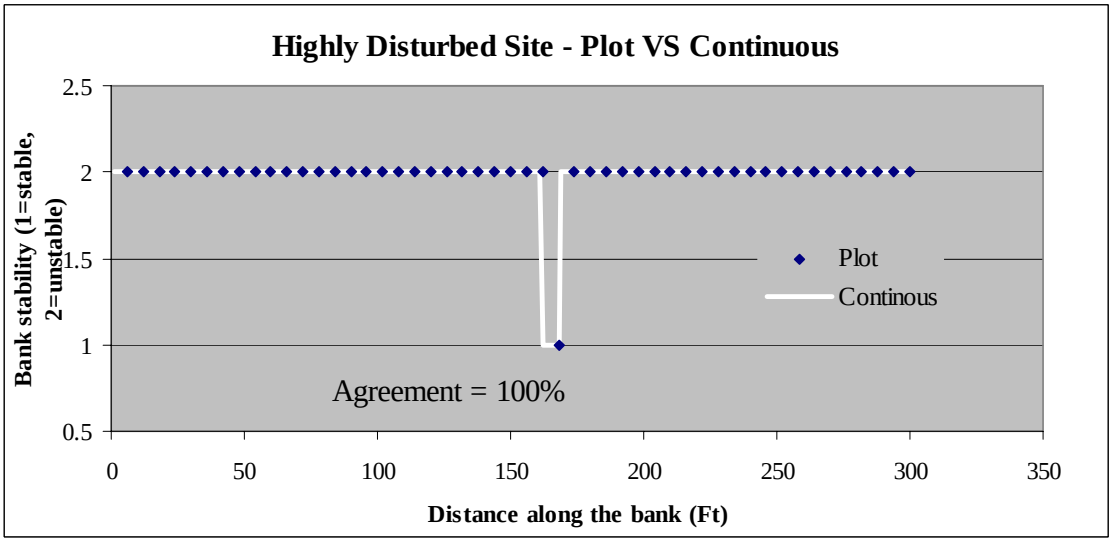


Figure 2. A comparison of streambank stability estimates along the greenline from plot and continuous observations in the highly disturbed (unstable) stream reach.

Appendix A

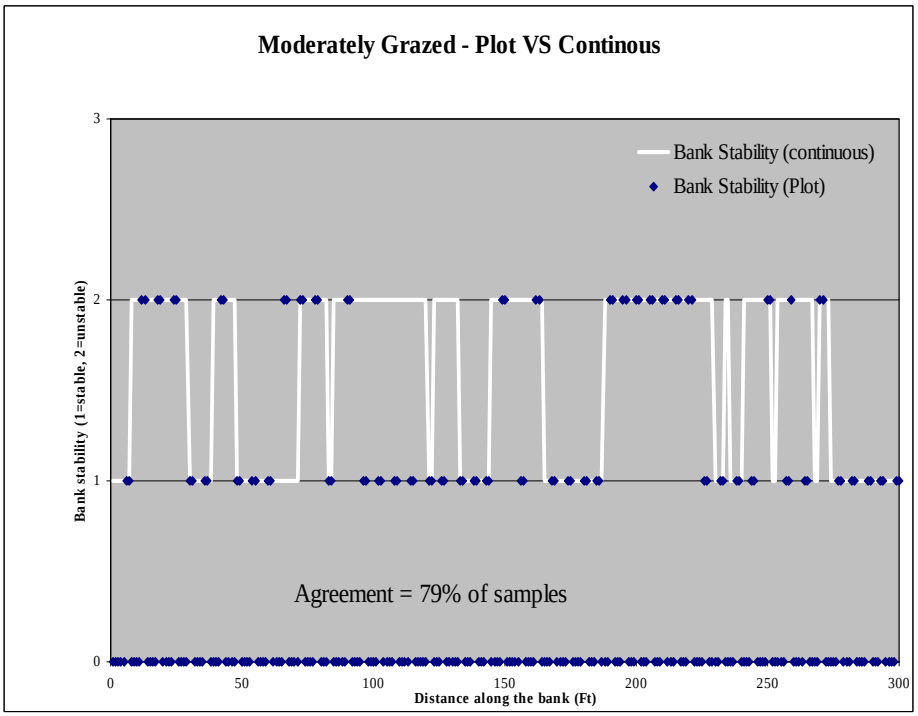


Figure 3. . A comparison of streambank stability estimates along the greenline from plot and continuous observations in the moderately grazed stream reach.

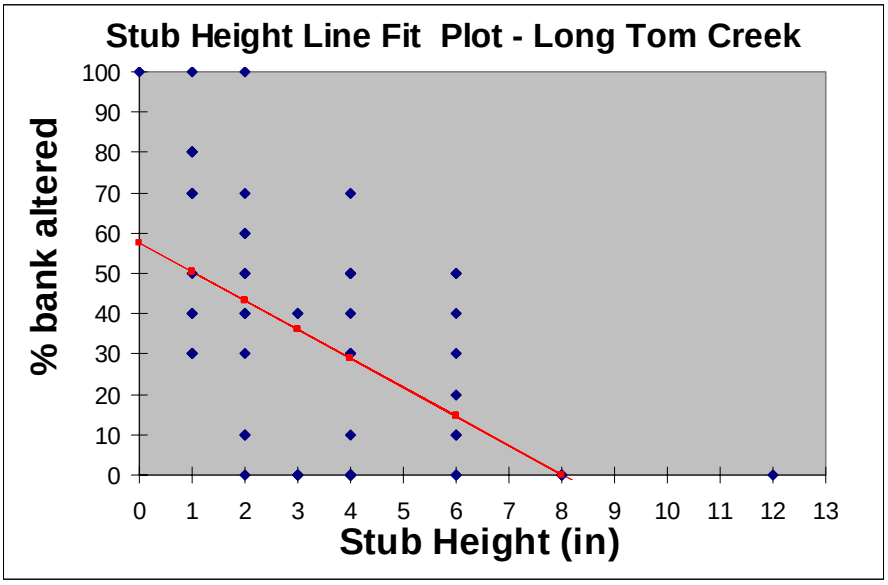


Figure 4. The relationship of stubble height to percent streambank alterated using the plot method on Long Tom Creek.

Appendix B
Greenline Location

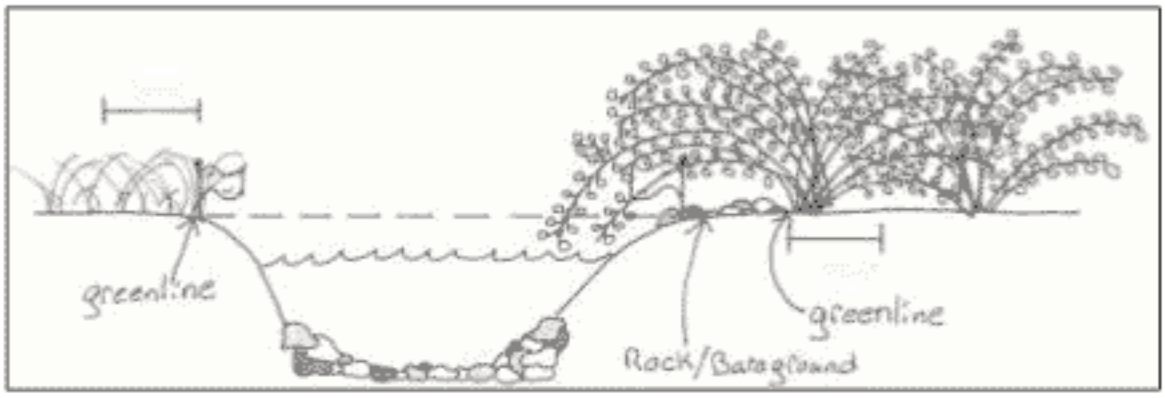


Figure 1—Greenline is located at the edge of rooted vegetation when the area under shrub or tree canopy is bare ground, rock, debris, or annual vegetation. (Coles-Ritchie, M, *et al.*, 2003)

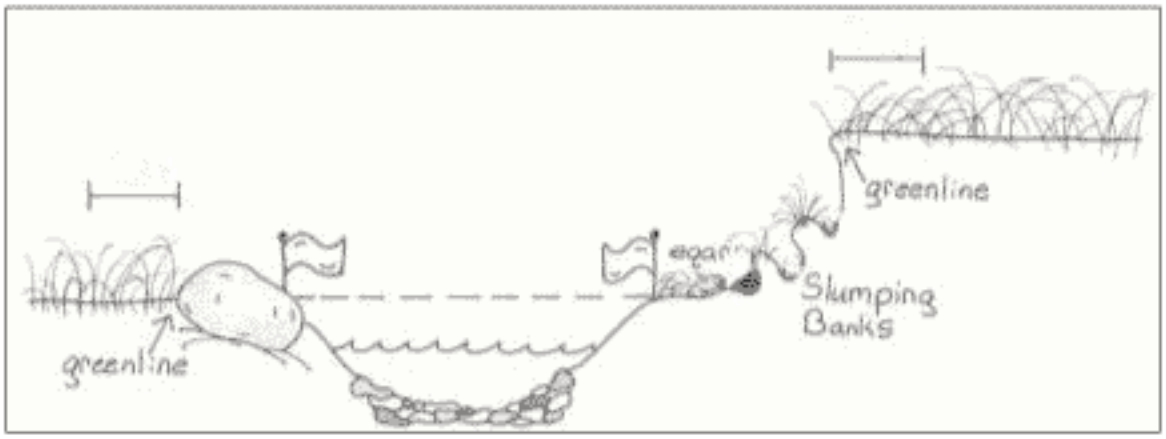


Figure 2—Greenline location with boulders, bare banks, slumping bank, and upland vegetation. (Coles-Ritchie, M, *et al.*, 2003)

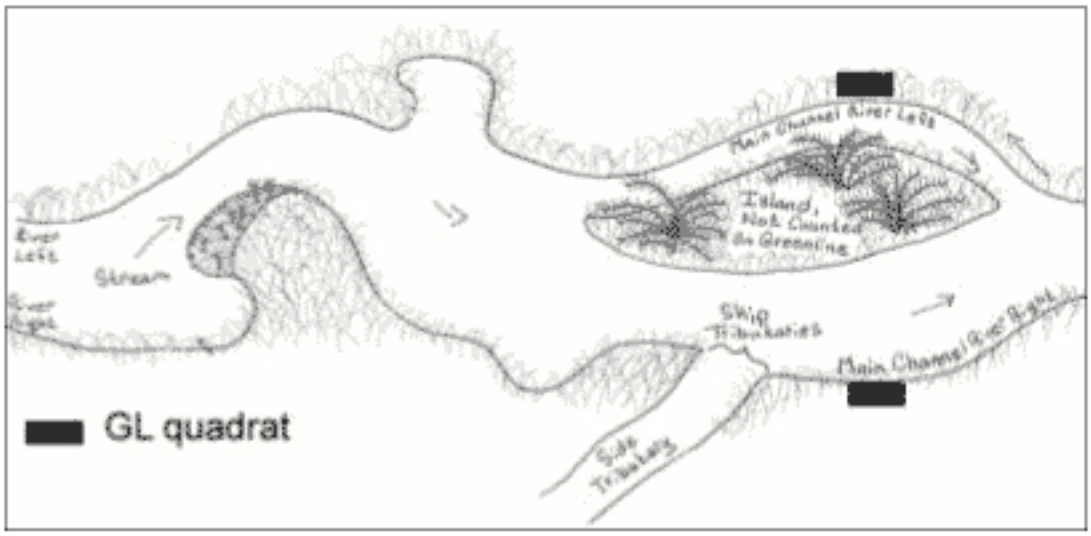


Figure 3—Greenline location in relation to various bank features. (Coles-Ritchie, 2003)

Appendix B
Greenline Location

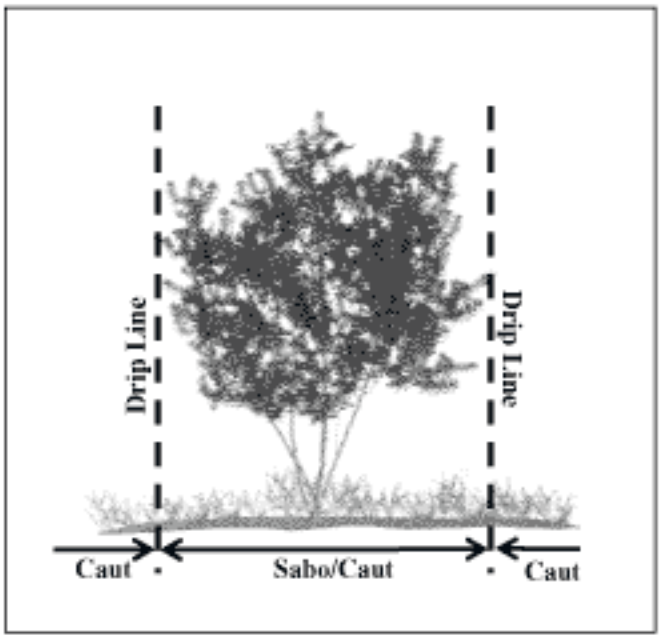


Figure 4—Record overstory when the plot is within the drip-line of a shrub or tree. The overstory species is always listed first in the vegetation community symbol. (Winword 2000)

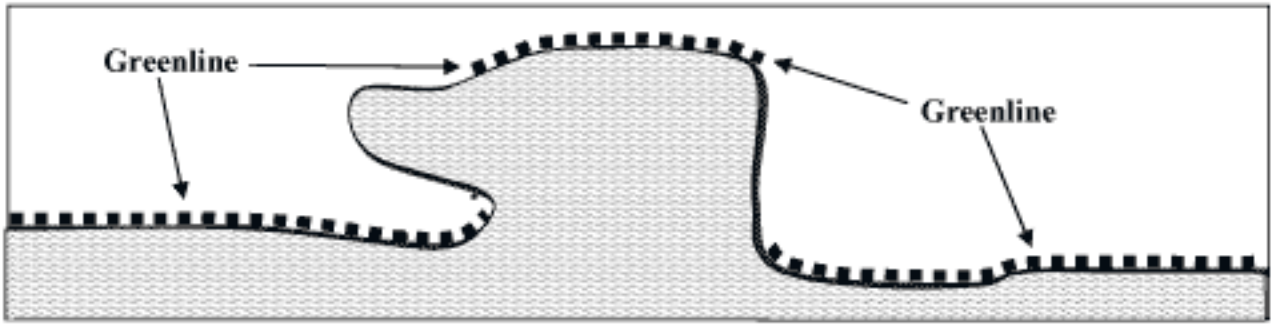


Figure 5—The greenline is on the streambank approximately parallel to the water flow. Streambanks perpendicular to the stream flow is not considered greenline.

Appendix B
Greenline Location

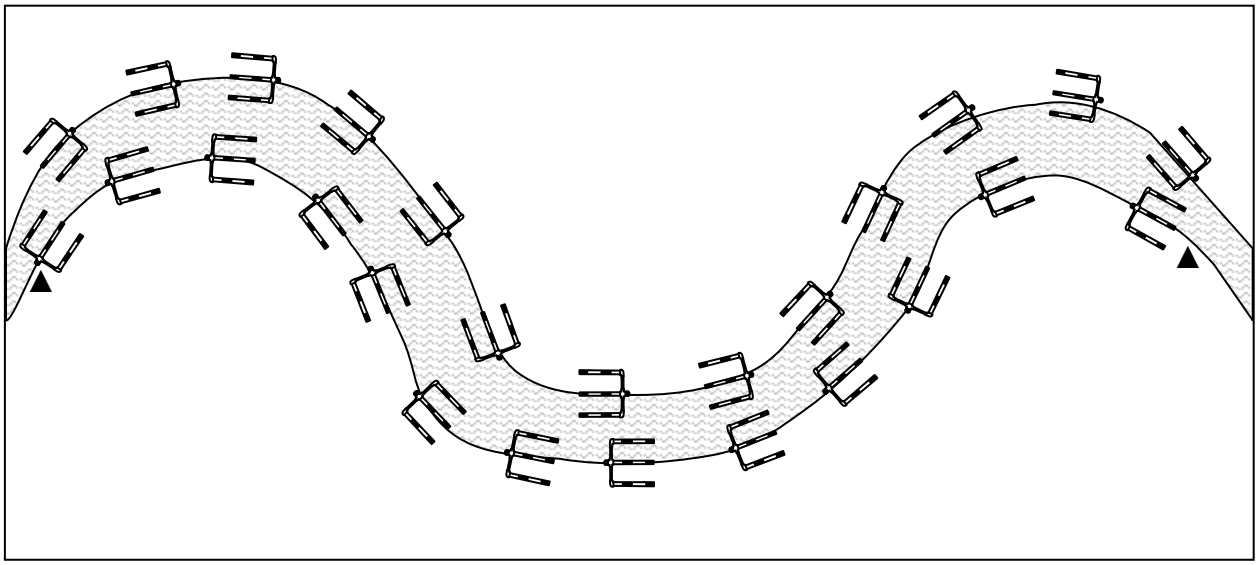


Figure 6—Placement of the monitoring frame along the greenline. Note that frame placement is not necessarily perpendicular to the placement on the opposite bank due to differences in greenline length.

Figure 7—The greenline is along the dashed line. To the right of the dashed line is the relatively continuous stand of perennial vegetation (mostly Kentucky bluegrass). To the right of the dashed line is bare ground and broken vegetation cover.

Appendix B
Greenline Location

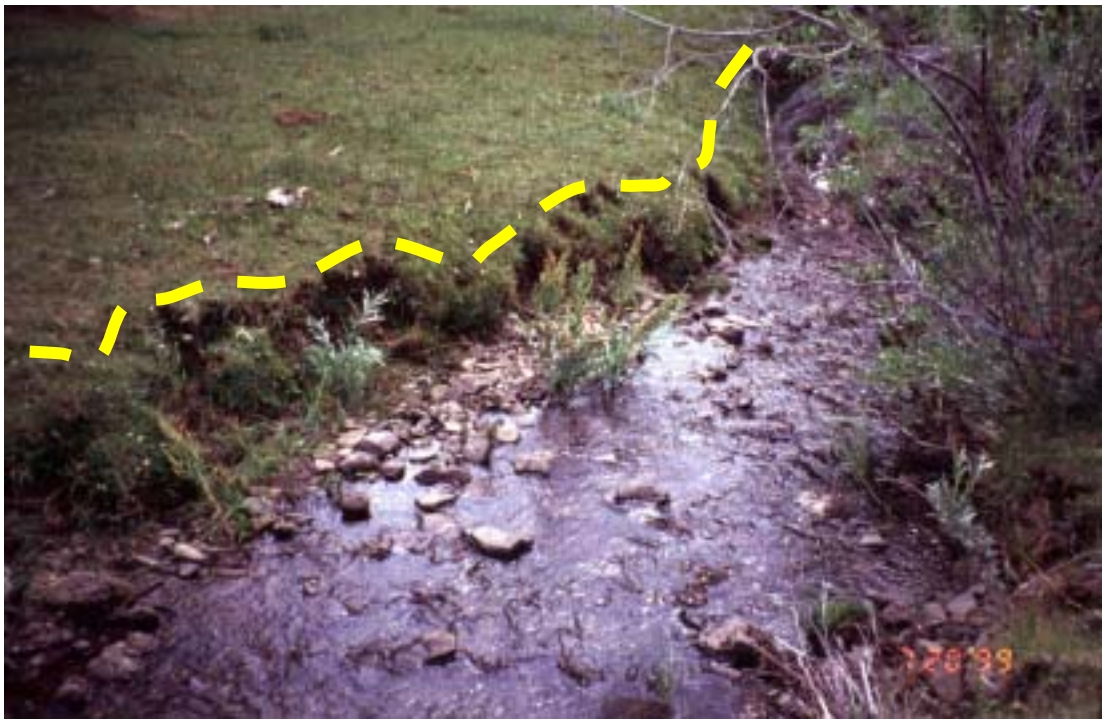


Figure 8—Greenline along an eroding streambank. Vegetation within the stream channel is a result of channel erosion.

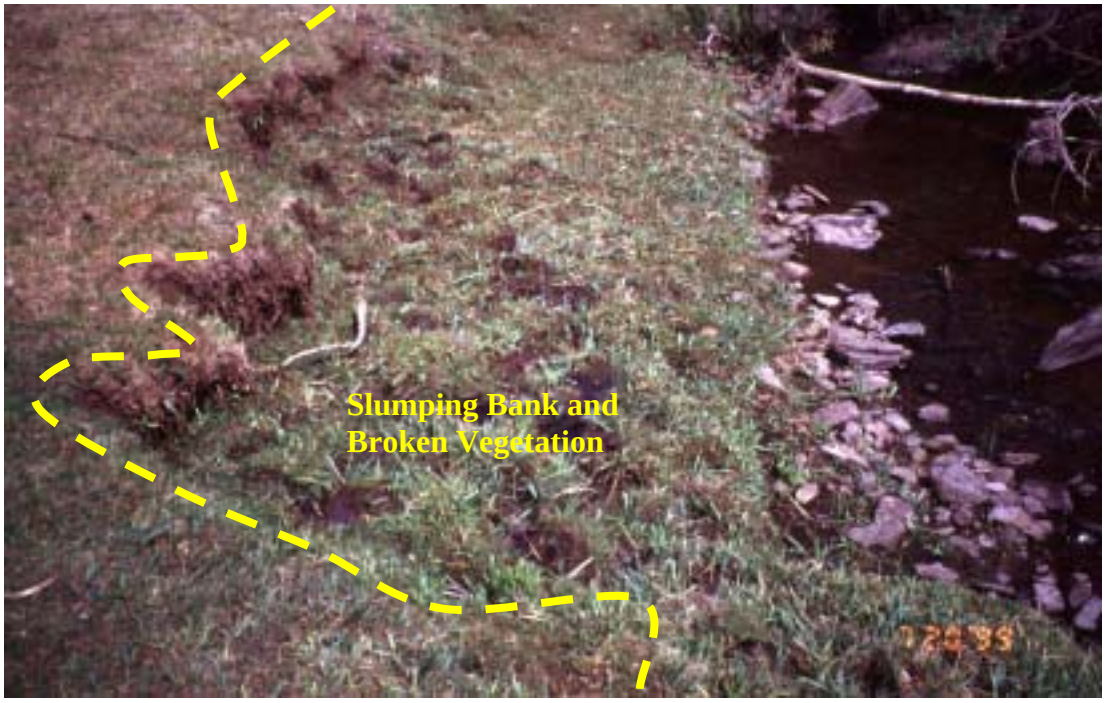


Figure 9—The greenline follows the dashed line. When the greenline is fingered as shown above, place the frame in a position across the fingers in an average location. Note the broken vegetation on an unstabilized slump feature to the right of the greenline.

Appendix B
Greenline Location

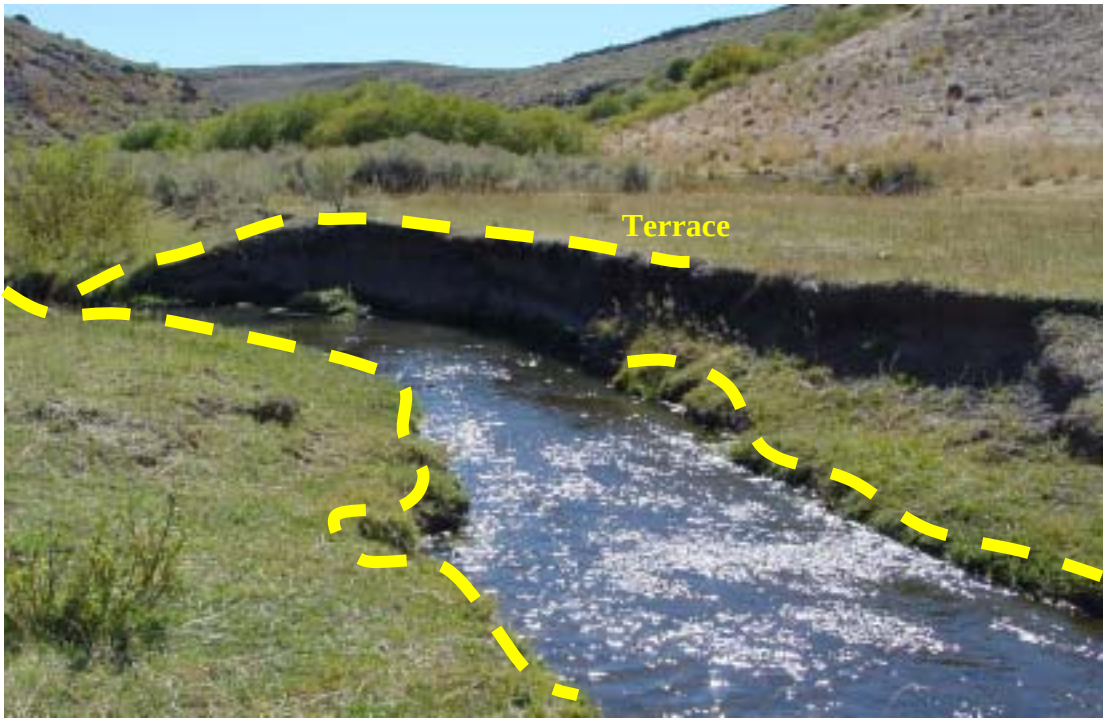


Figure 10—Greenline on the edge of the active floodplain and on top of the terrace.

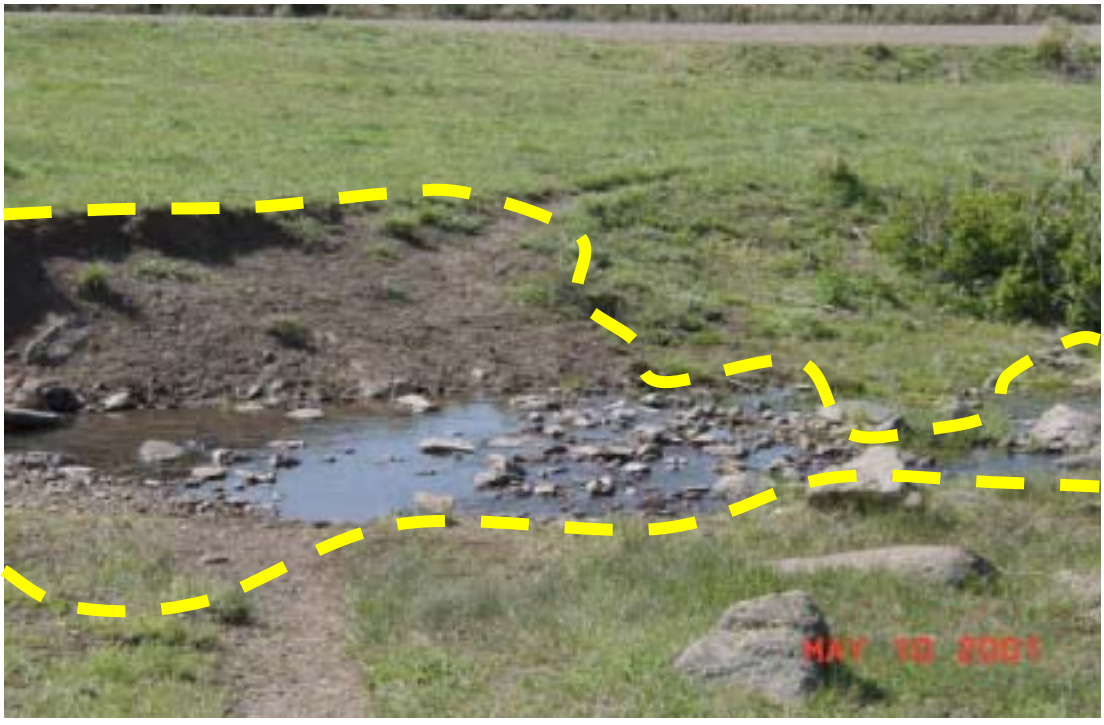


Figure 11—Greenline follows the vegetation line and crosses a livestock trail as a point where it narrows.

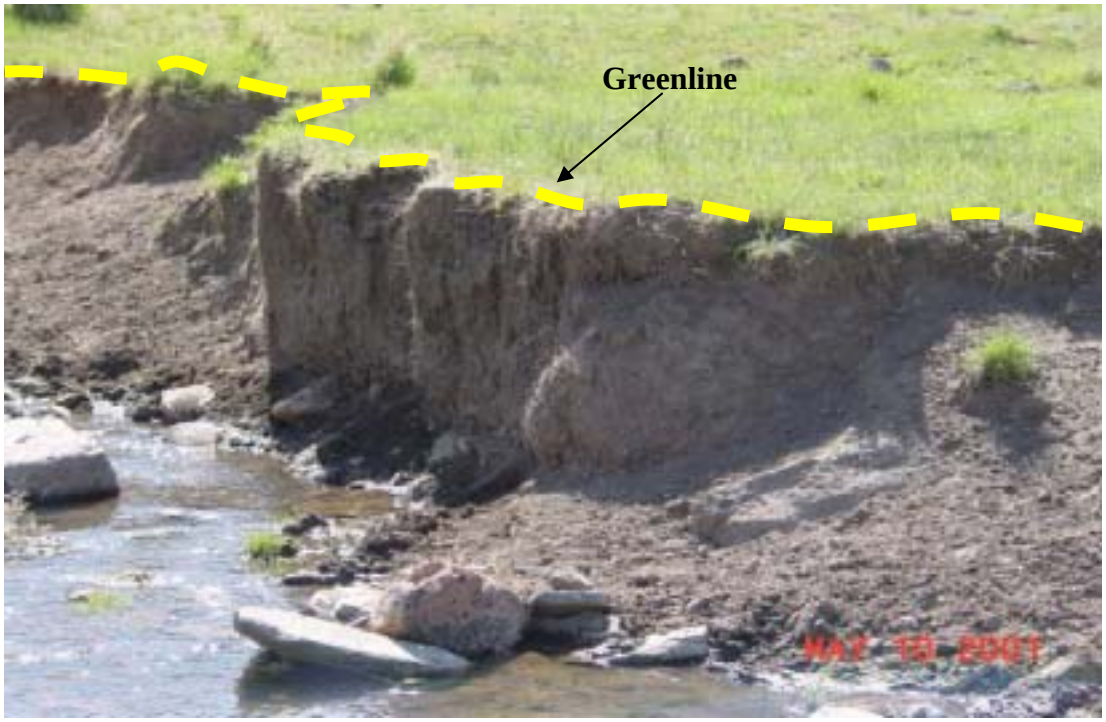


Figure 12—Greenline on a terrace with upland vegetation.

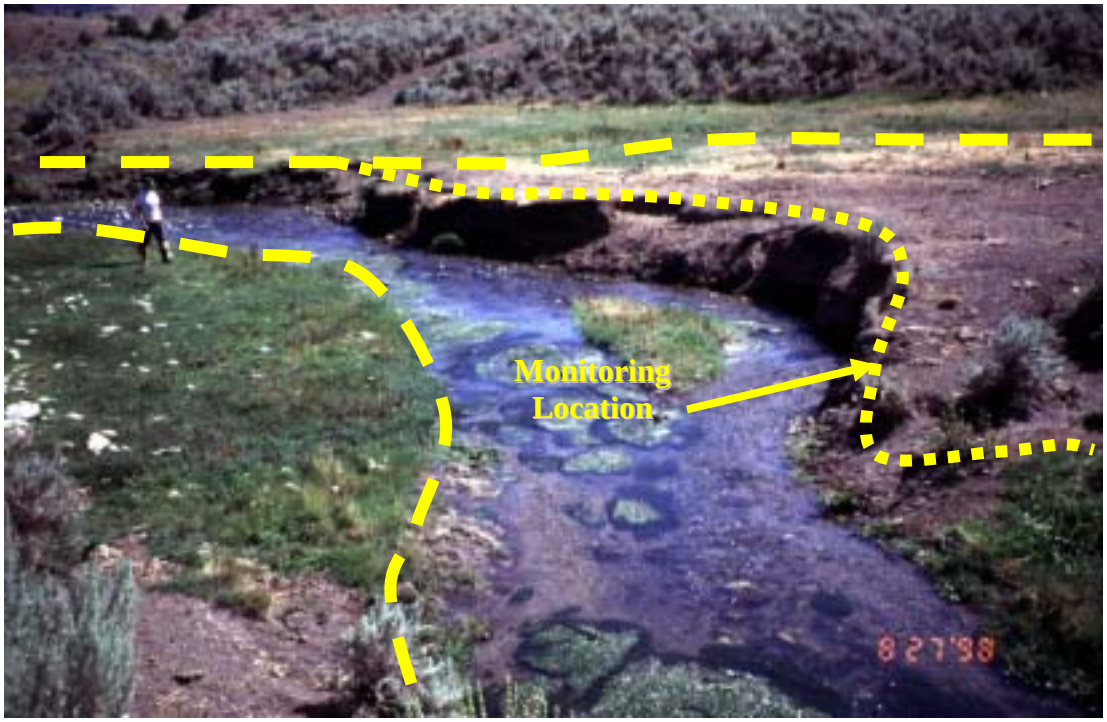


Figure 13—The greenline is located away from the streambank because only annual vegetation is located along the streambank. The fine dashed line shows the transect location.

APPENDIX C
Modified Daubenmire Monitoring Frame

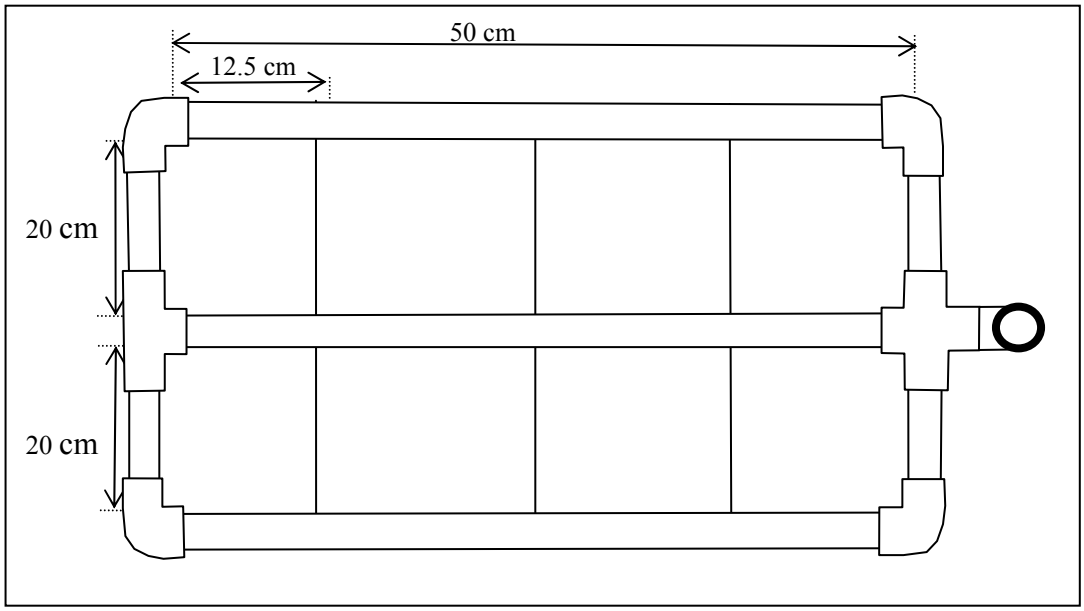


Figure 1—The streambank alteration plot consists of two 20 cm plots side-by-side separated by a ½ inch schedule 40 PVC pipe. The plot is subdivided with 8 cross-wires giving a total of 5 sample points within the frame (see Figure 2). The frame consists of twp pieces pipe 49.5 cm (19.6 inches), one piece of pipe 49 cm for the center divider, four pieces of pipe 20 cm (7.9 inches), one 3 foot piece of pipe for a handle, five ½ inch elbows, one ½ inch tee, one ½ inch cross, and eight stiff straight cross-wires (⅛ inch bronze welding rod, steel welding rod or other suitable material.

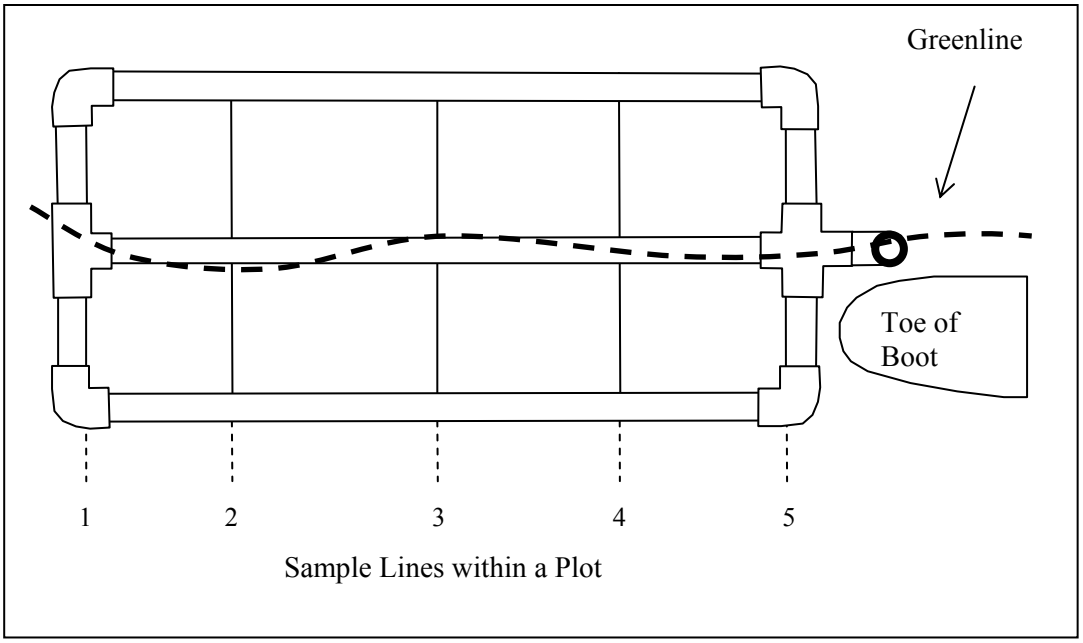


Figure 2—Shows the placement of the streambank alteration frame at the tip of the toe of the boot and along the greenline. The number of sample lines that intersect streambank alteration is determined (range 0 to 10) and recorded on the form.

APPENDIX C
Modified Daubenmire Monitoring Frame

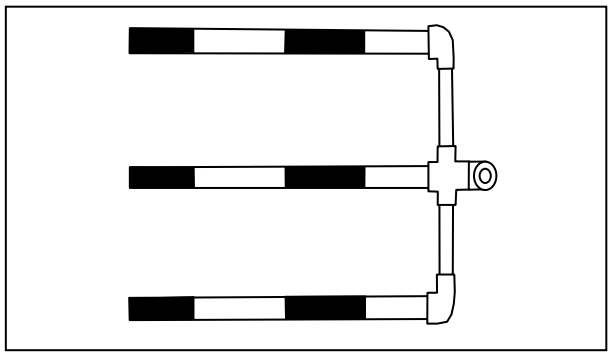


Figure 3—Modified streambank alteration plot with open ends is easier to get around woody species. Paint alternating colors bars alternating colors to define lines.

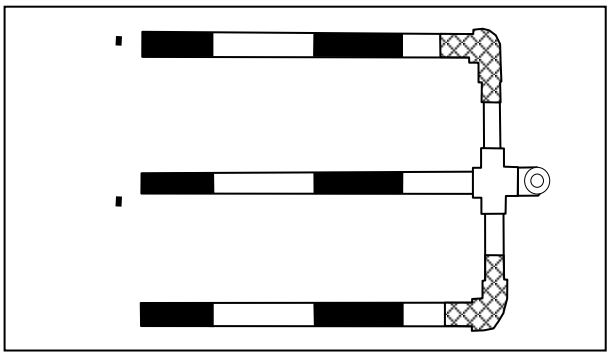


Figure 4—Open ended modified side-by-side modified Daubenmire plot frame. Paint the 25% subdivision one color and the 5% subdivision another color.

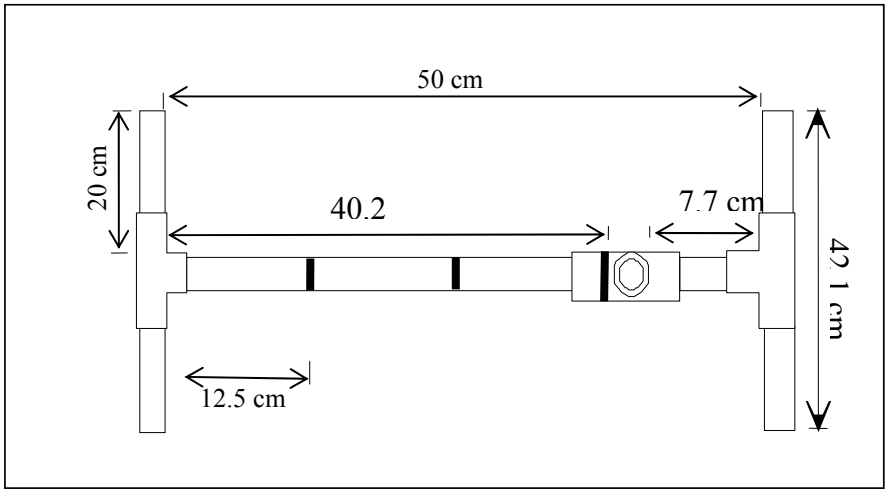


Figure 5--Components consist of three ½ inch PVC plastic tees, four pieces of ½ inch PVC pipe 6½ inches (19 cm) long, one 15¾ inches (40.2 cm) long, one piece of pipe 3 inch (7.7 cm) long, and one 3 foot piece for a handle. The handle may be a convenient length.

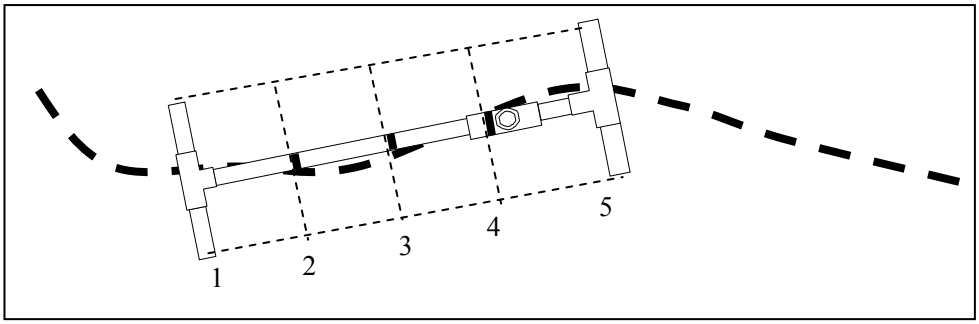


Figure 6--Place the alteration frame at the end of the toe with the center of the frame along the greenline. Determine and record the number of intercept lines with bank shearing or trampling.

APPENDIX D
Streambank Stability Classification Definitions and Key

Definitions

Scour Bank: The streambank subject to the erosive energy of the stream, depositional features are absent.

Base Flow: The typical low flow water level in a stream late in the season is usually after the spring snow-melt.

Depositional Bank: The streambank associated with sand, silt, clay, or gravel deposited by the stream.

Streambank: Morphological features of the stream channel created by the erosion and deposition forces of stream flow which control the lateral movement of water (Platts *et al* 1987). They are that part of a channel between the edge of the floodplain (bankfull) and the streambed. Streambanks are the steeper-sloped sides of the stream channel and are most susceptible to erosion during high flow events (Platts *et al* 1987). Streambanks form above the streambed where vegetation, roots, rocks, and other obstructions cause resistance to the flow energy (Rosgen 1996). Stability along the edge of the floodplain and just below the bankfull line are the most vulnerable to erosion by water scouring because bankfull levels occur almost every year (Leopold 1994). Most of the time, streambanks may be considered the area between the floodplain line (lowest part of the floodplain) and the base flow line, except deposition banks with a line of perennial vegetation line.

Floodplain Line: The upper limit of the streambank. The floodplain line (bankfull) is the level at which water first spills onto the lowest floodplain.

Scour Line: The lower or elevational limit of a streambank. The scour line is the elevation of the ceiling of undercut banks along steambanks. On depositional banks, the scour line is the lower limit of sod-forming or perennial vegetation. On small streams it is generally the base flow.

Covered: Perennial or sod-forming vegetation covers at least 50 percent of the height streambank (the vegetation line is usually at least 12 inches wide, but is subject to the stream size), cobbles, six inches or larger, anchored large woody debris (LWD) with a diameter of four inches or greater, or a combination of the vegetation, rock, and/or LWD is at least 50 percent.

APPENDIX D
Streambank Stability Classification Definitions and Key

I. Streambank absent (side channel, tributary, slew, road, etc.).....UN
II. Streambank present or should be present
  A. Streambank depositional
    1. Streambank not present due to excessive deposition ..... US
    2. Streambank is present (deposition not excessive)
      a. Bank covered .....CS
      b. Bank NOT covered (Bar).....UU
  B. Streambank erosional or a scour bank
    1. Streambank not fractured or the streambank is fractured with the slump block not longer attached to the streambank and is either lying adjacent to the breakage or is no longer present (see Appendix B)
      a. No crack is visible for the scour line up to a point 15 cm behind the top of the streambank
        (1) Bank covered
          i) Evidence of erosion not evident .....CS
          ii) Evidence of is evident (e.g., erosion, slumping, bank shearing) ..... CU
        (2) Bank NOT covered
          i) Bank angle within 10 degrees of vertical .....UU
          ii) Bank angle NOT within 10 degrees of vertical ..... US
      b. A crack or fracture feature is visible within 15 cm (6 inches) of the top of the streambank
        (1) Bank is covered.....CU
        (2) Bank is NOT covered .....UU
    2. Streambank is fractured <u>with</u> the slump block feature still attached
      a. The bottom of the slump block feature is below (elevationally) the scour line (view only the fracture feature behind the slump block)
        (1) Bank NOT covered
          i) Bank angle is within 10 degrees of vertical.....UU
          ii) Bank angle is NOT within 10 degrees of vertical ..... US
        (2) Bank covered .....CS
      b. The bottom of the fracture feature behind the slump block is above (elevationally) the scour line (view the bank as a slump block and the fracture feature as a vertical, exposed bank)
        (1) Bank or fracture feature NOT covered .....UU
        (2) Bank or fracture feature covered
          i) Fracture feature not covered.....CU
          ii) Fracture feature covered and reconnected.....FB

APPENDIX E--Streambank Stability Examples

Examples in this appendix provide some streambank stability scenarios. They should be used jointly with Appendices A and B and the descriptions provided in body of the protocol.

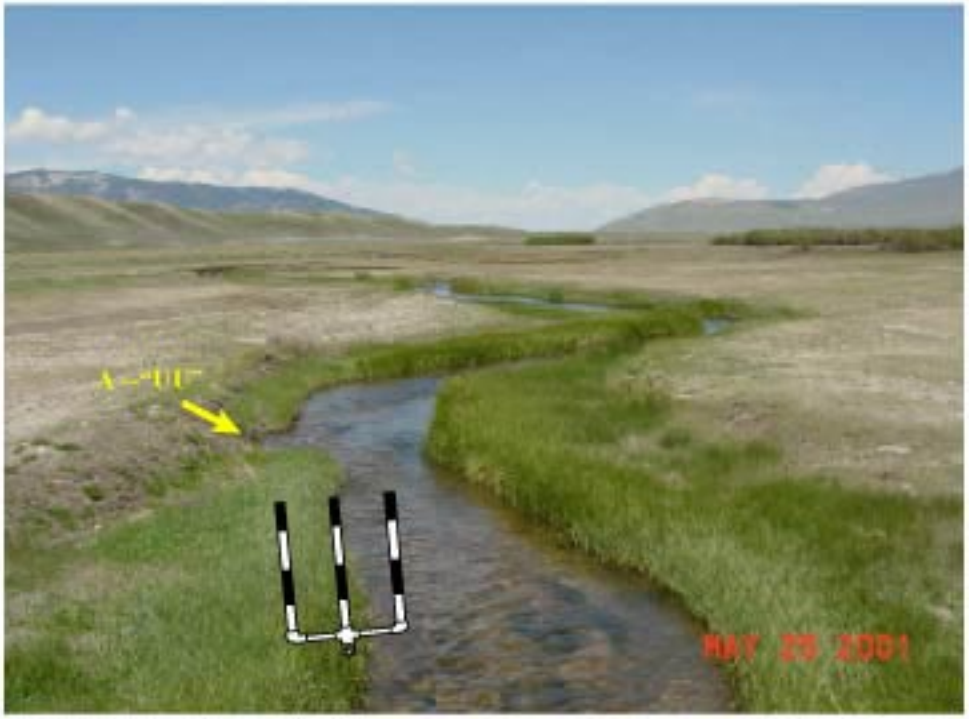


Figure 1-- Streambanks and floodplain covered with sedges and rushes, covered/stable, IIB 1a (1a). Note A is a small area of "uncovered/unstable" IIA 2a (2)(b)

Figure 2—The scour line as at the base flow and the bankfull line is near the perennial vegetation line. This bank is classified as uncovered/unstable, IIB 1a (2a).

Figure 3–"A" is an erosional bank with little cover, uncovered/unstable (IIA 2a (2)(a)). "B" is an erosional bank composed of bedrock, covered/stable (IIA 2a (1)(a)). "C" is a depositional streambank with non-continuous, weak-rooted, perennial pioneering vegetation (*Alopecurus aqualis*, short-awned oxtail), uncovered/unstable (IIA 1a (2))

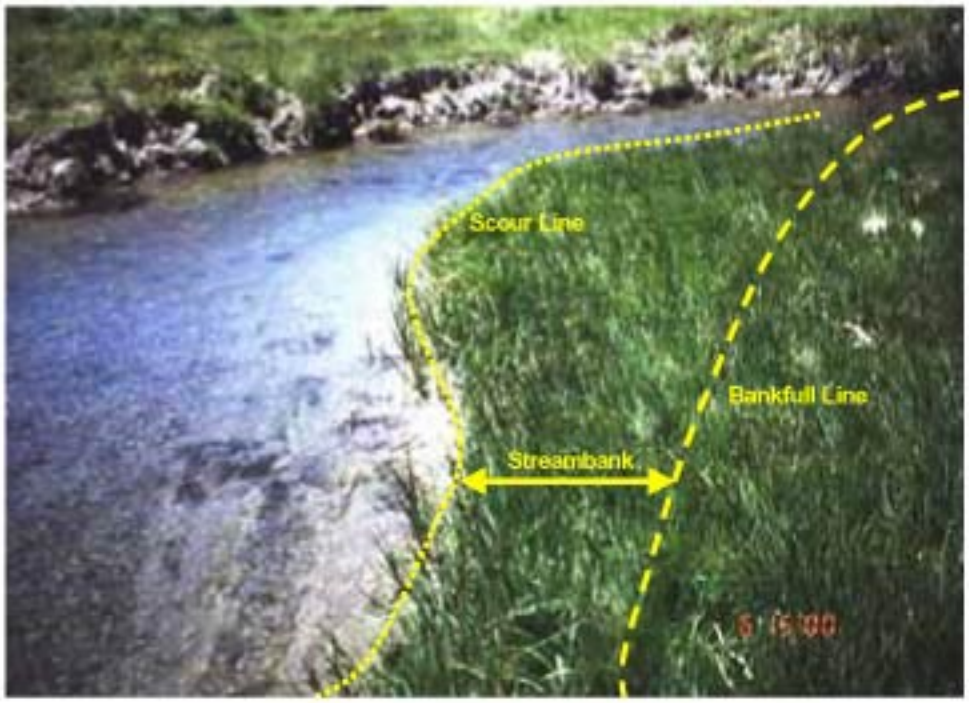


Figure 4—The streambank to be evaluated is between the scour line and the bankfull line. There a distinct change in the bank angle just below the bankfull line. This bank is covered/stable (CS), IIA 2a.

Figure 5--Streambanks covered with perennial sod-forming Kentucky bluegrass and low vigor Nebraska sedge and willows, covered/unstable (IIA 2a (1)(b)).

Figure 6–Slump blocks above the scour line. Vegetation on the blocks is upland and not considered deep-rooted. IIB 2b (2)

Figure 7–Left bank is not covered and the consolidated soil has resulted in a bank slope that is greater than 10 degrees from vertical, uncovered/stable (IIA 2a (2)(b). The right bank is covered with a continuous line of vigorous deep-rooted riparian vegetation, covered/stable (IIA 1b (a)).

Figure 8–Point bar with continuous line of perennial deep-rooted vigorous vegetation at least one foot wide, covered/stable (IIB 1b (1)(a))

Figure 9–Slump block features below the scour line and not considered part of the streambank. Cracks or fractures are above the scour line, uncovered/unstable (IIA 2b (2)).

Figure 10—The streambank to be evaluated is between the scour line and the bankfull line. There a distinct change in the bank angle just below the bankfull line. This bank is covered/stable (CS), IIA 2a.

Figure 11—The scour line is at the base flow level. The streambank is between the scour line and the bankfull line. There are a number of fracture features along the stream. The streambank has fracture features with the slump blocks no longer attached. "A" is covered/unstable (CU), IIB 1a (1b).

Figure 12—False bank is a slump block that is reattached and with vegetative cover.

Figure 13—Slump block reattached and vegetated. It is classified as a false bank and is covered/stable CS.

APPENDIX F
Streambank Alteration

Streambank Alteration Key

A. Streambanks have a relatively continuous cover of perennial vegetation (at least on one side of the greenline).
   a. Hoof prints expose little or no bare soil and/or roots (less than 12 mm [½ inch]) ..... No Alteration
   b. Hoof prints expose bare soil and/or roots (more than 12mm [½ inch]) ..... Alteration

B. Streambanks have a broken cover of perennial vegetation or are barren of vegetation (at least on one side of the greenline)
   a. Soils on the streambank is not compacted
      i. Hoof prints are less than 12 mm (½ inch) deep from the bottom of the impression to the top of the displaced soil..... No Alteration
      ii. Hoof prints are at least 12 mm (½ inch) deep from the bottom of the impression to the top of the displaced soil..... Alteration
   b. Soils on the streambank are compacted by large herbivores and/or with hoof print(s) on the compacted soil even if less than 12 mm (½ inch) deep .... Alteration

Figure 1—The greenline is along the orange dashed line. To the right of the dashed line is the relatively continuous stand of perennial vegetation (mostly Kentucky bluegrass). To the right of the dashed line is trampled bare ground and broken vegetation cover.

Figure 2—The greenline follows the dashed yellow line. The lineal grouping of perennial has over 50% vegetative cover.

Figure 3—Greenline along an eroding streambank, shearing is evident.

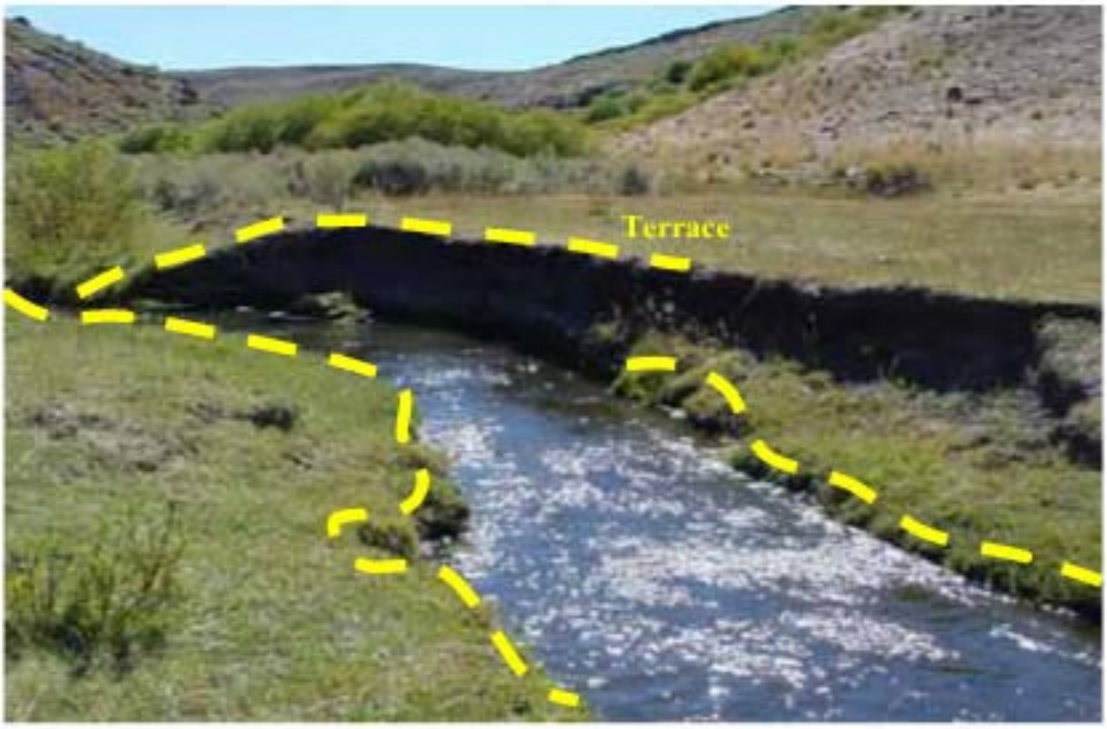


Figure 4—Livestock trampling top of the terrace (areas above the active floodplain) is not considered streambank alteration, except if livestock are trampling along the base of the streambank or shearing on the terrace wall. Stubble height measurements are not taken on the top of the terrace. Continue the transect until the hydric species are encountered.

Figure 5—Trampling along the green line (dashed line). Note trampling along the base of the vertical terrace wall (arrows). Record as such.

Figure 6--Livestock trail crossing the stream would be recorded as trampling even though the prints are less than ½ inch deep, due to compaction. Note the approximate bankfull line (dashed line).

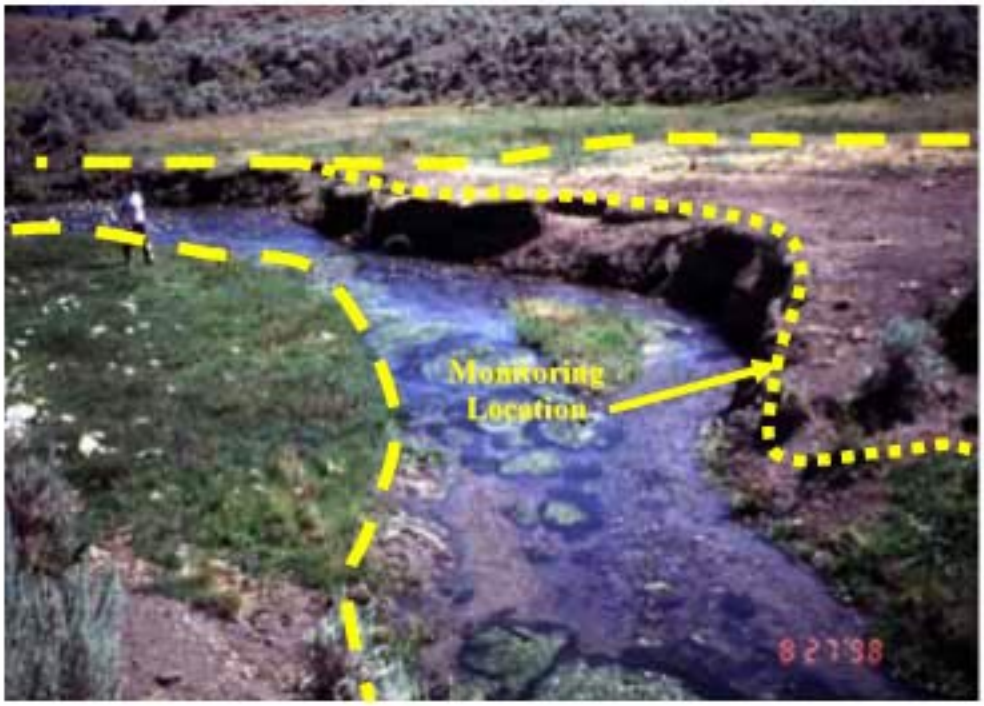


Figure 7—The greenline is located away from the streambank because only annual vegetation is located along the streambank. The fine dashed line shows the transect location.

Figure 8--Shearing is along the terrace wall and bank trampling has occurred and is recorded as such.

Figure 9—The greenline is below the water surface as the stream is above the base flow level. Note the greeline shifts from the terrace to the streambank where there is adequate vegetation

Figure 10—The water level is above bankfull, thus the greenline is in the water. Moving from right to left, the greenline follows the edge of the terrace until it reaches the vegetation along the water edge, it then shifts along the water's edge until it reaches the open area. It then shifts to back to the terrace, and then back to the water's edge.

Figure 11—Vegetation along stream has more than 50% vegetation cover and area of at least 50% of the quadrant.

Figure 12—Slump block detached from the streambank. The greenline follows the line of perennial vegetation on the at the higher level.

Figure 13—The slump feature is reattached the the streambank, thus the greenline is along the water's edge.

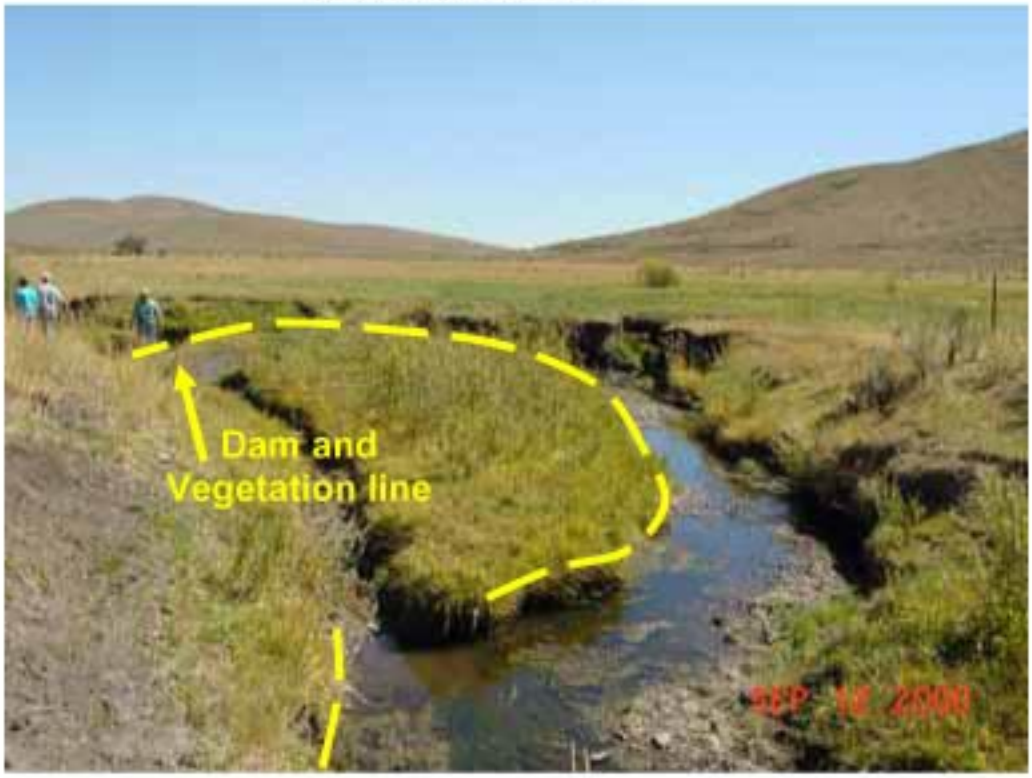


Figure 14—The greenline follows the vegetation line along the main channel because there is a dam and vegetation bridge at the lower end of the point bar. If an active channel continued creating an island, the greenline would follow the smaller channel and not on the island.

Figure 15—Vegetation in the stream channel is an island. The greenline remains at the edge of the terrace.

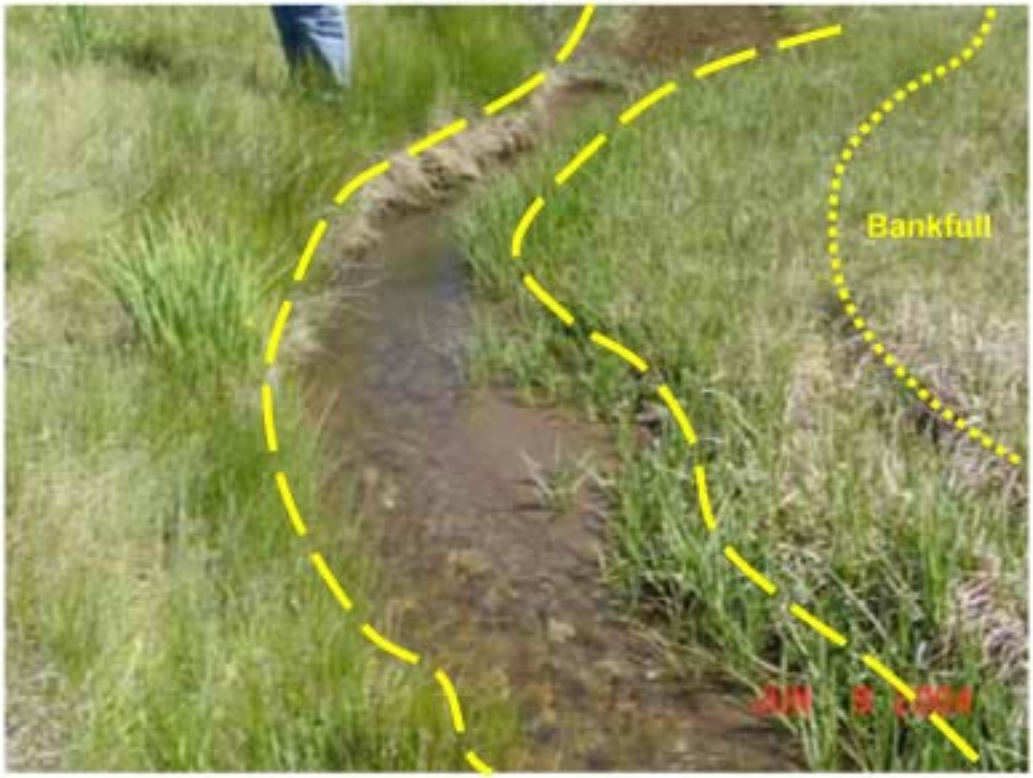
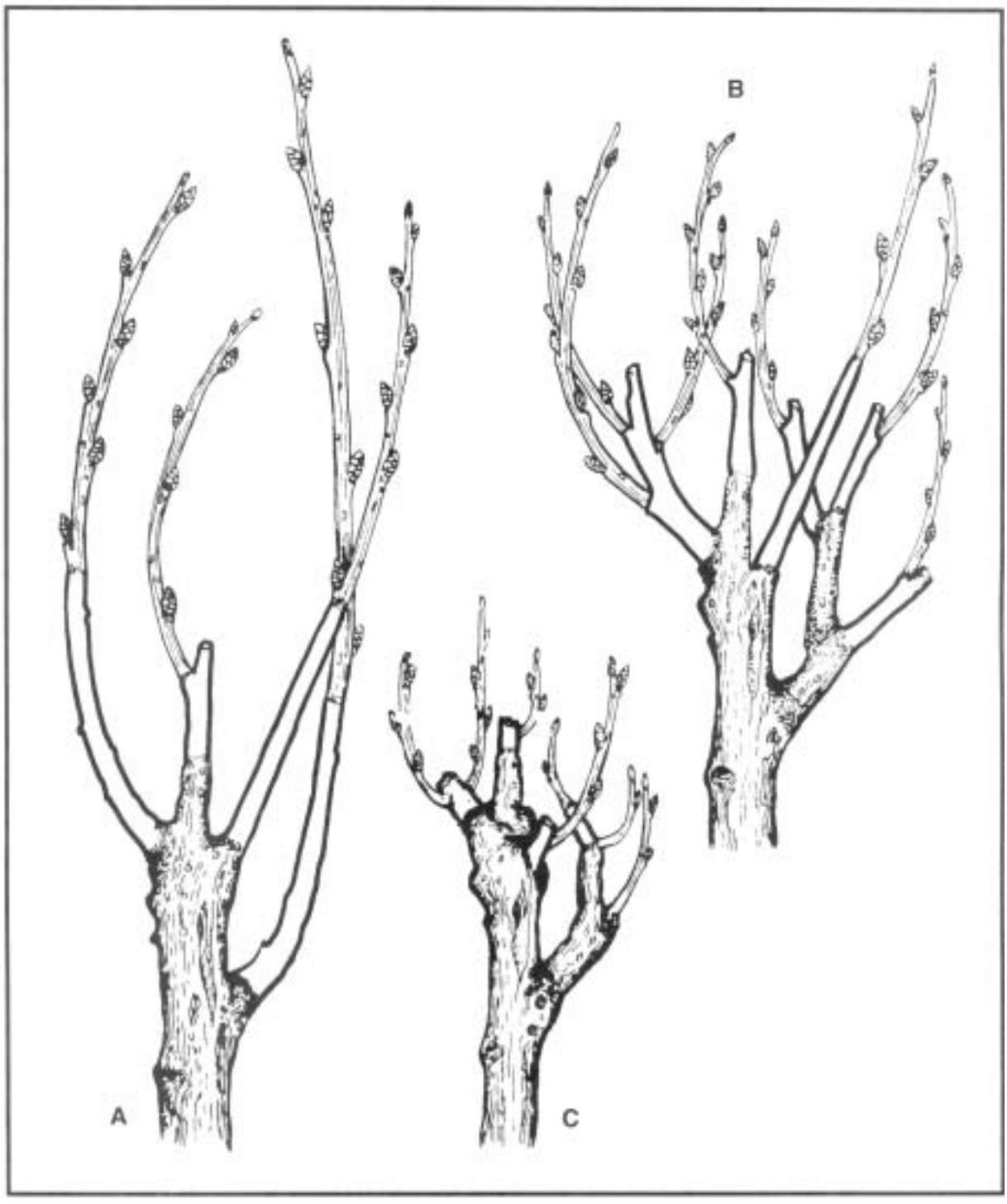


Figure 16—the greenline is near the water below bankfull narrowing the channel. The low water is a result of the drought conditions for past five years. Vegetation in the water is expanding from rhizomes and is less than 50% cover.

Appendix G

Degrees of Hedging



A = Zero to Light B = Moderate C = Severe

Interagency Technical Team. 1996. Utilization Studies and Residual Measurements. USDI, BLM. Denver, CO. p 150.

Modified Woody Species Regeneration
(Winward 2000)

Office	Allotment	Pasture	Date
Stream Name	Segment No.	Transect No./Name	
Transect Location		Examiner(s)	

Species	Right Bank (looking up stream)					Left Bank (looking up stream				
	Sprout	Young	Mature	Decadent	Dead	Sprout	Young	Mature	Decadent	Dead
Totals										
Summary Total (right bank + left bank)										

Comments on back:

MEDIAN RESIDUAL VEGETATION AT THE END-OF-SEASON

Administrative Unit:					
Allotment:					
Pasture/Use Area:					
Designated Monitoring Area (DMA):					
Key Species:					
Observer(s):				Date:	
Inches	DMA 1	DMA 2	DMA 3	DMA 4	DMA 5
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
>12					
Total Samples					
Midpoint(s)					
Median					

EXAMPLE

MEDIAN RESIDUAL VEGETATION AT THE END-OF-SEASON

Administrative Unit: Idaho, Outback FO					
Allotment: Box Car					
Pasture/Use Area: Floating Rock					
Designated Monitoring Area (DMA): T13N, R157W, SEC 23, NW1/4, SW1/4, SE1/4, NE1/4					
Key Species: Caut, Cane, Juba					
Observer(s): Ben Colder				Date: 1/15/99	
Inches	DMA 1	DMA 2	DMA 3	DMA 4	DMA 5
1	𝍸 III	𝍸 𝍸 I			
2	𝍸	𝍸			
3	𝍸	𝍸 I			
4	𝍸 I I	𝍸 𝍸 I *31*			
5	𝍸 *30*	𝍸 𝍸 II			
6	III 𝍸 *31*	𝍸			
7	𝍸	𝍸			
8	𝍸 III	𝍸			
9	𝍸 I				
10	I				
11					
12					
>12					
Total Samples Taken	60	61			
Midpoint(s)	30=5.0 31=6.0	31=4.0			
Median	5.5	4.0			

Streambank Stability

Allotment Name	Pasture Name	Monitoring Site No.
Stream Name	Location	Date
Observer(s)		

Streambank	Streambank Stability					
	CS (Stable)	CU (Vulnerable)	US (Vulnerable)	UU (Unstable)	FB (Stable/Vulnerable)	UN (Unclassified)
Right Bank (looking up stream)					Covered/stable Covered/Unstable	
Totals Steps						
Percent						
Total Steps-Right Bank						

Streambank	Streambank Stability					
	CS (Stable)	CU (Vulnerable)	US (Vulnerable)	UU (Unstable)	FB (Stable/Vulnerable)	UN (Unclassified)
Left Bank (looking up stream)					Covered/stable Covered/Unstable	
Total Steps						
Percent						
Total Steps-Left Bank						
Transect Totals						
Transect Percent						
Total Steps for transect-Right plus Left Banks						

Summary-Streambank Stability			
Stable	Vulnerable	Unstable	Unclassified

Put comments on back

RIPARIAN GREENLINE COMPOSITION
(Transect Plot Data)

Administrative Unit:		Date:
Drainage:		
		Photo No.:
Riparian Complex:		
Location:		
Transect No.:	Transect Length Feet/Meters:	

Community or Dominant Vegetation Type	Plots (Left looking up stream)	Plots (Right looking up stream)	Total Plots	% Comp
		Grand Total Plots		100

Computations:

$$\frac{\text{Total community or dominance type}}{\text{Grand Total Plots}} * 100 = \text{Percent community or dominance type composition}$$

Streambank Alteration

Administrative Unit:	
Allotment:	Pasture/Use Area:
Stream/Stream Segment:	Designated Monitoring Area:
Observer(s):	Date:

Left Bank (Looking Up Stream)								Right Bank (Looking Up Stream)							
	Alteration		Alteration		Alteration		Alteration		Alteration		Alteration		Alteration		Alteration
1		21		41		61		1		21		41		61	
2		22		42		62		2		22		42		62	
3		23		43		63		3		23		43		63	
4		24		44		64		4		24		44		64	
5		25		45		65		5		25		45		65	
6		26		46		66		6		26		46		66	
7		27		47		67		7		27		47		67	
8		28		48		68		8		28		48		68	
9		29		49		69		9		29		49		69	
10		30		50		70		10		30		50		70	
11		31		51		71		11		31		51		71	
12		32		52		72		12		32		52		72	
13		33		53		73		13		33		53		73	
14		34		54		74		14		34		54		74	
15		35		55		75		15		35		55		75	
16		36		56		76		16		36		56		76	
17		37		57		77		17		37		57		77	
18		38		58		78		18		38		58		78	
19		39		59		79		19		39		59		79	
20		40		60		80		20		40		60		80	
Total Alteration								Total Alteration							
% Altered (Lft Bank) =Total Altered ÷ (Total Samples X 5) X 100								% Altered (Rt Bank) =Total Altered ÷ (Total SampleX 5) X 100							
% Bank Alteration = Left Bank Alteration + Right Bank Alteration ÷ Total Samples X 5) X 100															

Comments: On Back

3/15/02

Extensive Browse

Administrative Unit:	**Date:**
Allotment:	**Pasture or Unit:**
Stream/Stream Segment:	Designated Monitoring Area:
Observer(s):	

Species	**Percent Utilized**											**Total % Utilized**	**Number of Plants**	**Average % Utilized**
	0	**10**	**20**	**30**	**30**	**50**	**60**	**70**	**80**	**90**	**100**			

Species	**Form Class**								**No. Plnt (and % Comp)**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Tot. No. Plnts (and % comp)									

Comments on back side

Appendix I – Selecting the DMA and Monitoring Indicators

SELECTING THE DESIGNATED MONITORING AREA (DMA) AND MONITORING INDICATORS TO ASSESS STREAM/RIPARIAN GRAZING

1. The DMA should be established appropriate to the monitoring indicators as described in Appendix J.

2. It should be representative of grazing use specific to the riparian area being assessed.

3. It should not reflect an "average" amount of use in all riparian areas of the stream reaches in the pasture but rather reflect livestock use in only those stream reaches where livestock are actually using riparian areas.

4. Select from those areas that are most critical in influencing fish species and where those areas overlap with grazing use –
    a. Listed fish habitat?
    b. Spawning habitat?
    c. Critical over wintering or rearing habitat?

5. Avoid areas where the impacts to fish species are compounded by other activity types or by non-USFS or BLM livestock grazing activities.

6. Premise: "If proper management occurs on the area, the remainder of the pasture or use area will also be managed within requirements."

7. Avoid sites that are impervious to disturbance (e.g. rock-armored channels) or those intentionally established for concentrated use (e.g. water gaps).

8. Select DMAs in an interdisciplinary fashion, including specialists knowledgeable in fish habitat requirements, channel processes, riparian vegetation, and livestock grazing.

Interdisciplinary DMA Selection Procedure

Monitoring must be conducted within the same Riparian Complex (Winward 2000). Riparian complexes are defined by overall geomorphology, substrate characteristics, stream gradient, and vegetation patterns along the stream. They develop and function in response to interacting features of valley bottom gradient, substrate or soil characteristics, valley bottom width, elevation, and climate. Once the Riparian Complex is defined, the DMA should be located by an ID Team to "best represent influences of major activities in that complex" (Winward 2000).

Step 1. Define the Riparian Complex(s) within the pasture

Obtain information on the stream within the pasture in the office using USGS topographic map(s), aerial photo(s), and soils or landtype inventories.

a. Graph the stream profile – note average grades and breaks – classify the stream gradient type using Rosgen's criteria (Appendix I).
b. Evaluate valley width, noting any abrupt changes within the pasture. Classify the Valley Type using Rosgen's Valley Morphology classification.
c. Determine the dominant soil family type from the Soils Inventory or Landtype maps, noting key substrate characteristics – texture, potential vegetation, flooding, etc.
d. Evaluate vegetation patterns along the stream noting key groupings of woody types and herbaceous types where possible from the photos.
e. Map the Riparian Complexes within the pasture based upon changes in Stream Gradient Type, Valley Type, and/or Dominant Soil Families.

Step 2. Define the appropriate monitoring indicators for the Riparian Complex

a) Use the outline in Appendix 2 to select the monitoring indicators appropriate to the Stream Gradient type and vegetation cover type in the riparian complex

Step 3. Locate the Designated Monitoring Area and transect in the field

b) Walk through the Riparian Complex in the pasture to be monitored.
c) Validate the mapped Riparian Complex and adjust descriptions as necessary
d) Evaluate grazing use along and adjacent to the stream. Note where use occurs and the types of use – herbaceous and/or woody browse
e) Select a monitoring reach typical of the grazing use and that overlaps any critical aquatic habitat – spawning and/or early rearing reaches, etc.

a. Make sure it does not include a cattle crossing or local point of concentration
b. The starting point for the transect may be randomly selected by going to the downstream end of the reach, selecting a random number between 1 and 10, and then pacing-off that number of steps upstream.
c. At the starting point place a stake adjacent to the stream and well back from the edges of any cutbanks. The stake should be located above the bankful elevation of the stream.
d. Place a stake to demark the ending point of the transect across the stream from the starting point (the transect will proceed upstream from the starting point a distance of at least 363 feet, cross the stream and proceed from that point downstream to a stake located across the stream from the starting point).
e. Place stakes on each bank at the upstream end of the reach to define the transect extent.
f. If multiple channels are encountered, the current, most active channel should be followed. Do not sample streambanks on islands in the stream.

Appendix I – Selecting the DMA and Monitoring Indicators

A. Channel Type descriptions (Rogen 1996, p. 4-5).

Channel type	Description	Entrench-ment ratio	W/D ratio	Sinuosity	Slope	Landform
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels	> 2.2	>12	>1.4	<.02	Broad valleys with terraces. Well defined meandering channels
E	Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition.	>2.2	<12	>1.5	<.02	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous. Very low width/depth ratio.
F	Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio	<1.4	>12	>1.4	<.02	Entrenched in highly weathered material. Gentle gradients with high bank erosion rates.
G	Entrenched "gully" step/pool and low width/depth ratio on moderate gradients	<1.4	<12	>1.2	.02 to .039	Gullies, step/pool morphology. Narrow valleys or deeply incised in alluvial or colluvial materials. Unstable with high bank erosion rate.
B	Moderatly entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools.	1.4 to 2.2	>12	>1.2	.02 to .039	Moderate relief, colluvial deposition, and/or structural. Narrow, gently sloping valleys.
A	Steep, entrenched, cascading, step-pool streams. Very stable if bedrock or boulder dominated.	<1.4	<12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrneched and confined streams with cascading reaches.

Appendix I – Selecting the DMA and Monitoring Indicators

B. Valley Morphology Types (Rosgen 1996, pages 4-12 to4-20)

Valley Type	Shape	Channel Types represented	Valley Slope %	Typical substrate	Landforms
II	Broad V-shape or narrow u-shape in colluvial valleys	"B"	<4%	Cobble and boulder from alluvium and colluvium	Cryoplanated uplands with colluvial slopes. – in narrow valley
III	Broad V-shape filled with alluvial fans and debris cones	"A", "B", "G", and "D"	>2%	Cobble and boulder	Colluvial and alluvial side-slope fans in the v-shaped valley
IV	V-shaped confined in entrenched canyon	"F" and "C"	<2%	Sand to Cobble	Entrenched meanders (gorges) in confined alluvial valleys
V	Wide, u-shaped valley	"C", "D", and "G"	<4%	Sand to cobble	Moraines, terraces, and floodplains in wide, u-shaped valley
VI	Broad V-shape or narrow U-shape	"B"	<4%	Sand to cobble	Fault-line valley with steeper slopes on one side of the valley
VIII	Wide, flat valley shape	"C" and "E"	<2%	Sand to cobble	Alluvial terraces and floodplains in broad valley
IX	Wide, flat	"C" and "D"	<2%	Sand to gravel	Glacial outwash plain
X	Very wide, flat plain	"C", "E", and "DA" with "G" and "F"	<2%	Sand to gravel	Broad lacustrine and alluvial flats
XI	Broad, flat to lobate shapes	"DA", "D", "C", and "E"	<2%	Sand to gravel	River deltas, tidal flats.

APPENDIX J--GUIDE TO THE SELECTION OF MONITORING INDICATORS

The following Guide (University of Idaho Stubble Height Review Team, 2004) can be used to prescribe streamside monitoring methods appropriate for various channel types (Rosgen, 1996), and existing and potential vegetative conditions along the greenline. Descriptions of the Channel Types are contained in Appendix I.

I. "C" channel type, herbaceous vegetation dominant, potential vegetation: herbaceous or mixed herbaceous and shrubs.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Use compliance (livestock numbers and time in pasture).
  - Bank disturbance or alteration

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stablizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Bank disturbance or alteration

- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
  - Streambank stability
  - Greenline composition maintained or trend toward hydric stablizers

II. "C" channel type, mixed shrub - herbaceous vegetation dominant, potential vegetation: mixed herbaceous and shrubs, or shrubs.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Stubble height on key riparian species or species groups on the greenline
  - Use compliance (livestock numbers and time in pasture).
  - Bank disturbance or alteration
  - Change in preference to woody species sprouts and young

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stablizers:**
  - Stubble height on key riparian species or species groups on the greenline
  - Bank disturbance or alteration
  - Incidence of use on woody sprouts and young

- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
  - Streambank stability
  - Greenline composition maintained or trend toward hydric stablizers
  - Woody species regeneration – 15-20% sprouts and young, 60-70% mature, and 15-20% dead

- **III. "C" channel type, woody dominant, potential vegetation: shrubs and trees.**


- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Use compliance (livestock numbers and time in pasture).
  - Bank disturbance or alteration
  - Change in preference to woody species sprouts and young

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stablizers:**
  - Bank disturbance or alteration
  - Incidence of use on woody sprouts and young

- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
  - Streambank stability
  - Woody species regeneration – 15-20% sprouts and young, 60-70% mature, and 15-20% dead
  -

IV. "E" channel type, herbaceous vegetation dominant, potential vegetation: herbaceous or mixed herbaceous and shrubs.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
    - Stubble height on key riparian species, or species groups on the greenline.
    - Use compliance (livestock numbers and time in pasture).
    - Bank disturbance or alteration

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stablizers:**
    - Stubble height on key riparian species, or species groups on the greenline.
    - Bank disturbance or alteration.

- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
    - Streambank stability.
    - Greenline composition maintained or trend toward hydric stablizers

V. "F" channel type (entrenched floodplain), herbaceous vegetation dominant, potential vegetation: herbaceous or mixed herbaceous and shrubs.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Stubble height on key riparian specie, or species groups s on the greenline.
  - Use compliance (livestock numbers and time in pasture).
  - Bank disturbance or alteration

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stablizers:**
  - Stubble height on key riparian species, or species groups on the greenline.
  - Bank disturbance or alteration.

- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
  - Streambank stability.
  - Greenline composition maintained or trend toward hydric stablizers

VI. "G" channel type (entrenched – no floodplain), herbaceous vegetation or bare banks dominant. Potential vegetation: herbaceous.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
    - Use compliance (livestock numbers and time in pasture).
    - Bank disturbance or alteration

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stablizers:**
    - Bank disturbance or alteration.

- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
    - Streambank stability.
    - Greenline composition maintained or trend toward hydric stablizers

VI. "B" channel type, mixed shrub - herbaceous vegetation dominant, potential vegetation: mixed herbaceous and shrubs, or shrubs.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Use compliance (livestock numbers and time in pasture).
  - Bank disturbance or alteration
  - Change in preference to woody species sprouts and young

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stablizers:**
  - Stubble height on key riparian species, or species groups on the greenline
  - Bank disturbance or alteration
  - Incidence of use on woody sprouts and young

- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
  - Streambank stability
  - Greenline composition maintained or trend toward hydric stablizers
  - Woody species regeneration – 15-20% sprouts and young, 60-70% mature, and 15-20% dead

- **VII. "B" channel type, woody dominant, potential vegetation: Shrubs and trees.**


- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Use compliance (livestock numbers and time in pasture).
  - Bank disturbance or alteration

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stablizers:**
  - Bank disturbance or alteration
  - Incidence of use on woody sprouts and young

- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
  - Streambank stability
  - Woody species regeneration – 15-20% sprouts and young, 60-70% mature, and 15-20% dead

VIII. "A" channel. Mixed shrubs and herbaceous, or shrubs dominant. Potential vegetation: mixed shrubs and herbaceous, or shrubs. Substrate large.

- **TRIGGER: Within-season trigger to move livestock, to maintain or increase vigor on key hydric stabilizers:**
  - Use compliance (livestock numbers and time in pasture).
  - Bank disturbance or alteration
  - Change in preference to woody species sprouts and young

- **ENDPOINT: End-of-season indicator of proper use to maintain or ensure increased composition key hydric stablizers:**
  - Bank disturbance or alteration
  - Incidence of use on woody sprouts and young

- **RIPARIAN OBJECTIVE: Long-term indicator of riparian condition to assess attainment of the Riparian Management Objectives**
  - Streambank stability
  -
  - Woody species regeneration – 15-20% sprouts and young, 60-70% mature, and 15-20% dead

Herbaceous vegetation does not normally contribute significantly to the stability of A channels. The rare exception would likely be associated with A5 and A6 channel types. A5's are steep channels incised in sandy materials and that occur on highly weathered granites or sedimentary rocks. Such channels often experience natural bank erosion through fluvial and earthflow processes. A6's are steep, entrenched channels in weathered shales and lacustrine soils that are very cohesive. These channels tend to be naturally unstable, but herbaceous vegetation may contribute some stability. Overgrazing may exacerbate an already unstable situation in steep channels with fine substrates.

Using Pocket EXCEL and Field PDAs

Use Pocket EXCEL to enter data and to track sample size adequacy.

You can import Pocket EXCEL files to the PC version and then run the Macro's to fill in the Database table.

To do this, copy the data entry cells of the Pocket EXCEL file and paste them into the data entry cells of this version, then Press Ctrl m to run the Macros

Entering data

The data entry cells are the non-colored cells in the "grazing use" and "riparian" spreadsheets.

Colored cells are locked to avoid erasing formulae. To unlock the cells, "Tools", "Protection", "Unlock Sheet", Password = "monitoring"

Example data are in the startup sheet - save this file as the backup - enter data into copies of this file.

The Database contains summary data for each monitoring indicator. It is located in the "Database" worksheet

Enter data for a site into the spreadsheets "grazing use" and "riparian". **Press Crtl m** to send the summary data to the "Database". Note: you are given the option to clear all data in BOTH spreadsheets (grazing use, and riparian). If you select yes, all data are cleared making the sheet ready for new data entry.

Statistics

This system is designed to allow data entry while evaluating sample size adequacy.

The "Stats" spreadsheet describes the statistics used to evaluate sample size adequacy.

Each spreadsheet also contains a cell for generating a Random Number. Put the indicated formula into that cell and then press the F9 key to generate the number (do not press ENTER to generate the random #).

Riparian Form - Vegetation Data

Vegetation codes are provided in the drop-down list to maintain consistency in dominant or subdominant vegetation types

See which plants these codes represent in "Veg_codes" worksheet. The Codes are based on Winward (2000).

Always use the same name for the same type of vegetation, do not mix names

The names on this form do not have to coincide with the vegetation types on the Grazing Use form

If the plant you have is not in the list, enter the code after the last cell (bottom of list) in "Veg_codes".

Woody Regen classes are as in Winward (2000): ss - sprout, y - young, m - mature, dec - decadent, dd - dead

Bank Stability classes are as in the protocol: cs - covered stable, cu - covered unstable, us - uncovered stable, uu - uncovered unstable

Grazing use

Enter key herbaceous species names into "Key herbaceous species" on right hand side of spreadsheet

Enter key woody species names into "keywoodys" on right hand side of spreadsheet

Herbaceous Specie - is the type of plant for which stubble height was measured.

Woody specie - is the plant type for which browse utilization was estimated

Methods

See Protocol - (Cowley and Burton,2004)

Riparian Monitoring Data Sheet
Streambank and Riparian Condition

Date: ______________

RD/FO:		**Forest/District:**	**Date:**
Alloment Name:		**Stream Name:**	
Pasture Name:		**Designated Monitoring Area (DMA) No.:**	
UTM N:	**UTM E:**	**Observer(s):**	
Step Interval:	**Step Length:**		

	Riparian Vegetation		Streambank		Stubble Height		Woody Species Regeneration						Woody Use	
Plot No.	Dominant	Sub-dominant	Percent altered (0 to 5)	stability class	Key Specie	Average Height	Specie	Seeding	Young	Mature	Decadent	Dead	Specie	Percent Use

Riparian Monitoring Data Sheet

Streambank and Riparian Condition

DMA No.: ____________

Date: ______________

	Riparian Vegetation		Streambank		Stubble Height		Woody Species Regeneration						Woody Use	
Plot No.	Dominant	Sub-dominant	Percent altered (0 to 5)	stability class	Key Specie	Average Height	Specie	Seeding	Young	Mature	Decadent	Dead	Specie	Percent Use

Date: ______________

Riparian Monitoring Data Sheet
Streambank and Riparian Condition

	Riparian Vegetation		Streambank		Stubble Height		Woody Species Regeneration						Woody Use	
Plot No.	Dominant	Sub-dominant	Percent altered (0 to 5)	stability class	Key Specie	Average Height	Specie	Seeding	Young	Mature	Decadent	Dead	Specie	Percent Use

Riparian Monitoring Data Sheet

Streambank and Riparian Condition

DMA No.: ___________

Date: _____________

	Riparian Vegetation		Streambank		Stubble Height		Woody Species Regeneration						Woody Use	
Plot No.	Dominant	Sub-dominant	Percent altered (0 to 5)	stability class	Key Specie	Average Height	Specie	Seeding	Young	Mature	Decadent	Dead	Specie	Percent Use

Comments and Notes:

Vegetation

acne	*Acer negundo*
agsc	*Agrostis scabra*
agst	*Agrostis stolonifera*
alaq	*Alopercurus aequalis*
alar	*Alopecurus arundinaceus*
alge	*Alpecurus geniculatus*
alin	*Alnus incana*
anki	*Angelica kingii*
arca	*Artemesia Cana*
artrt	*Artemesia tridentata*
asch	*Aster chiliensis*
asin	*Aster integrifolius*
barren	Bare ground
beoc	*Betula occidentalis*
caaq	*Carex aquatilis*
caaq2	*catabrosia aquatica*
cabu	*Carex buxbaumii*
caca	*Calamagrostis canadensis*
cado	*Carex douglasii*
cala1	*Carex lasiocarpa*
cala2	*Carex lanuginosa*
cale	*Caltha leptosepala*
cale	*carex lenticularis*
cali	*Carex limonsa*
cami	*Crex microptera*
cane1	*Calamagrostis neglecta*
cane	*Carex nebrascensis*
carda	*Cardamine*
casa	*Carex saxitilis*
casc	*Carex scopulorum*
casi	*Carex simulata*
caut	*Carex utriculata*
ciar	*Cirsium arvense*
conif	*conifer*
cose	*Cornus seicia*
dain	*Danthonia intermidia*

Bank stability

cs	Covered - Stable
cu	Covered - Unstable
uu	Uncovered - Unstable
us	Uncovered - Stable
un	Unclassified (tributaries)
fb	False bank (if used)

Woody Regeneration

ss	seedlings/saplings - 1 rooted stem
y	young - 2 to 10 rooted stems
m	mature > 10 stems + >50% alive
dec	decadent >10 stems + <50% alive
dd	dead - no live stems

dece	*Deschampsia cespitosa*
doje	*Dodecatheon jeffreyi*
elpa1	*Eleocharis palustris*
elpa2	*Eleocharis pauciflora*
equar	*Equisetum arvense*
equis	*Equisetum*
glyce	*Glyceria*
hobr	*Hordeum brachyantherum*
hoju	*Hordeum jubatum*
irmi	*iris missouriensis*
juba	*Juncus balticus*
juen	*Juncus ensifolius*
log	Anchored log
lupo	*Lupinus polyphyllus*
mear	*Mentha arvensis*
meci	*Metensia ciliata*
mf	*Mesic forb*
mg	*Mesic graminoid*
migu	*mimulus guttatus*
muan	*Muhlenbergia andina*
muri	*Muhlenbergia richardsonis*
naof	*ansturtium officinale*
phar	*Phalaris arundinacea*
phma	*Pragmites communis*
picea	*Picea*
pico	*Pinus contorta*
poan	*Populus angulstifolia*
pofr	*Potentilla fruticosa*
pone	*Poa nevadensis*
popr	*Poa pratensis*
popul	*Populus*
potr	*Populus tremuloides*
prvi	*Prunus virginiana*
raaq	*Ranunculus aquatilis*
rhal	*Rhamnus alnifolia*
rock	anchored rock
rowo	*rosa woodsii*

sabe	*Salix bebbiana*
sabo	*Salix boothii*
Sadr	*Salix drummondiana*
saea	*Salix eastwoodiae*
saex	*Salix exigua*
sage	*Salix geyeriana*
sala1	*Salix lasiandra*
sala2	*Salex lasiolepis*
sale	*Salex lemmonii*
salix	*Salix*
salu	*Salix lutea*
saor	*Salix orestera*
sapl	*Salix planifolia*
sawo	*Walix wolfii*
scac	*Scirpus actus*
scmi	*Scirus microcarpus*
scpu	*Scirpus pungens*
soca	*Solidago canadensis*
tyla	*Typha latifolia*
urdi	*Urtica dioica*
veam	*Veronica americana*
veca	*Veratrum californicum*
scsp	*Scirpus species*
juef	

Sample Size Estimator 0

$n = (Z_{æ})^2 (s)^2 / (B)^2$

Where:

n = The sample size estimate.
$Z_{æ}$ = The standard normal coefficient from the table below.
s =The standard deviation.
B = The desired precision level expressed as half of the maximum acceptable confidence interval width.
This needs to be specified in absolute terms rather than as a percentage. For example, if you wanted your confidence interval width to be within 30% of your sample mean and your sample mean = 10 plants/quadrat then B = (0.30 x 10) = 3.0.
Table of standard normal deviates ($Z_{æ}$) for various confidence levels

Confidence level	Alpha (æ) level	($Z_{æ}$)
80%	0.2	1.28
90%	0.1	1.64
95%	0.05	1.96
99%	0.01	2.58